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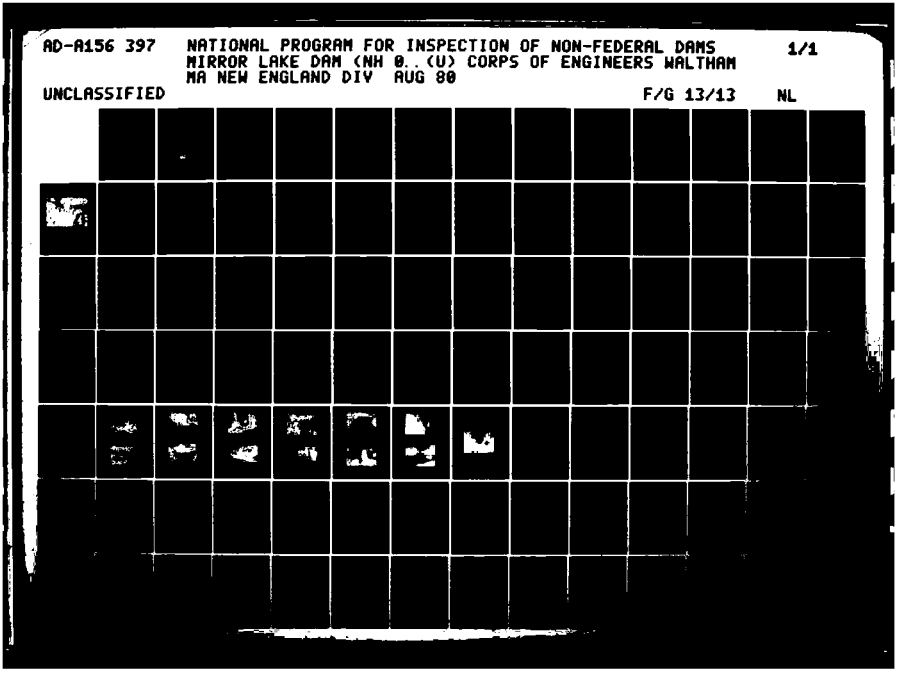

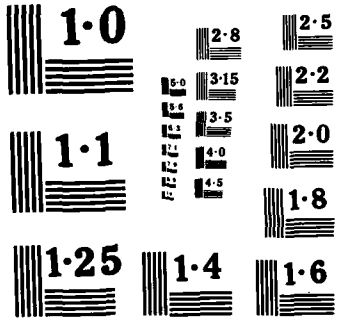

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

MERRIMACK RIVER BASIN
WOODSTOCK, NEW HAMPSHIRE

MIRROR LAKE DAM
N.H. 00317

STATE NO 259.07

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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4. TITLE *(and Subtitle)* Mirror Lake Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Woodstock New Hampshire
Tributary to Hubbard Brook

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

THe dam is a concrete gravity dam housing two stoplogs spillway bays with earth embankments wxtendein to the east and west of the concrete structure. It is 290 ft. long with a hydraulic height of 11.5 ft. The dam is in poor condition. Trees and brush growing on the embankments, and a lack of erosion protection on the upstream slopes and crests of both embankments are of major concern. It is small in size with a significant hazard potential.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

NOV 14 1980

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Mirror Lake Dam (NH-00317) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, New Hampshire Water Resources Board, Concord, N.H.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

Incl
As stated

MIRROR LAKE DAM

NH00317

MERRIMACK RIVER BASIN

WOODSTOCK, NEW HAMPSHIRE

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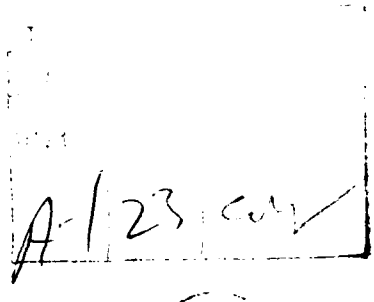

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00317
Name of Dam:	Mirror Lake Dam
Town:	Woodstock
County and State:	Grafton, New Hampshire
Stream:	Tributary to Hubbard Brook
Date of Inspection:	July 9, 1980

BRIEF ASSESSMENT

Mirror Lake Dam is a concrete gravity dam housing two stoplog spillway bays with earth embankments extending to the east and west of the concrete structure. The dam has a total length of 290 feet and a hydraulic height of 11.5 feet. The east earth embankment is approximately 117 feet long with a crest width of about 13 feet while the west earth embankment has a crest width of about 15 feet and a length of 159 feet. Dimensions of the east and west stoplog spillway bays are 5'W x 8.6'H and 5'W x 3.8'H, respectively. A 1.5-foot wide concrete buttress separates the two bays. Starting from the east training wall a one foot wide concrete core wall extends 14 feet into the east earth embankment. Beginning at the west training wall a one foot wide concrete retaining wall extends 26 feet along the upstream face of the west earth embankment. The dam impounds Mirror Lake, which has a maximum storage capacity of about 750 acre-feet. The reservoir is 2100 feet in length with a surface area of approximately 37 acres. The dam is located on the northwest side of the State of New Hampshire in the White Mountain National Forest region.

The dam is in poor condition. Major concerns are the trees and brush growing on the embankments, a lack of erosion protection on the upstream slopes and crests of both earth embankments, a major bulge and the growth of large birch trees in the dry-stone-masonry wall which retains the downstream side of the west earth embankment and a large, soft, wet area at the downstream toe of the west earth embankment.

Mirror Lake Dam has a small size and significant hazard classification based on its storage volume and potential for loss of less than a few lives and appreciable property damage should the dam breach. In accordance with the Recommended Guidelines for Safety Inspection of Dams, the test flood may range from the 100-year to ½ Probable Maximum Flood (PMF). The test flood selected was ½ PMF because of the potential for loss of life and because its storage capacity is in the upper end of the small size classification. The watershed is steeply sloping and wooded with no significant storage areas in the upstream watershed. The test flood inflow for a drainage area of 0.34 square miles was determined to be 434 cfs (1275 csm). Routing of this inflow to determine the modifying effects of surcharge storage resulted in a test flood outflow of 175 cfs (515 csm) at elevation 697.3' NGVD. This would cause the dam to be overtopped by 0.6 feet assuming the stoplogs are in place to elevation 695.0' NGVD. Spillway capacity at top of dam is 73 cfs which is 42 percent of the routed test flood outflow.

The owner, the New Hampshire Water Resources Board, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Mirror Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MARTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capability and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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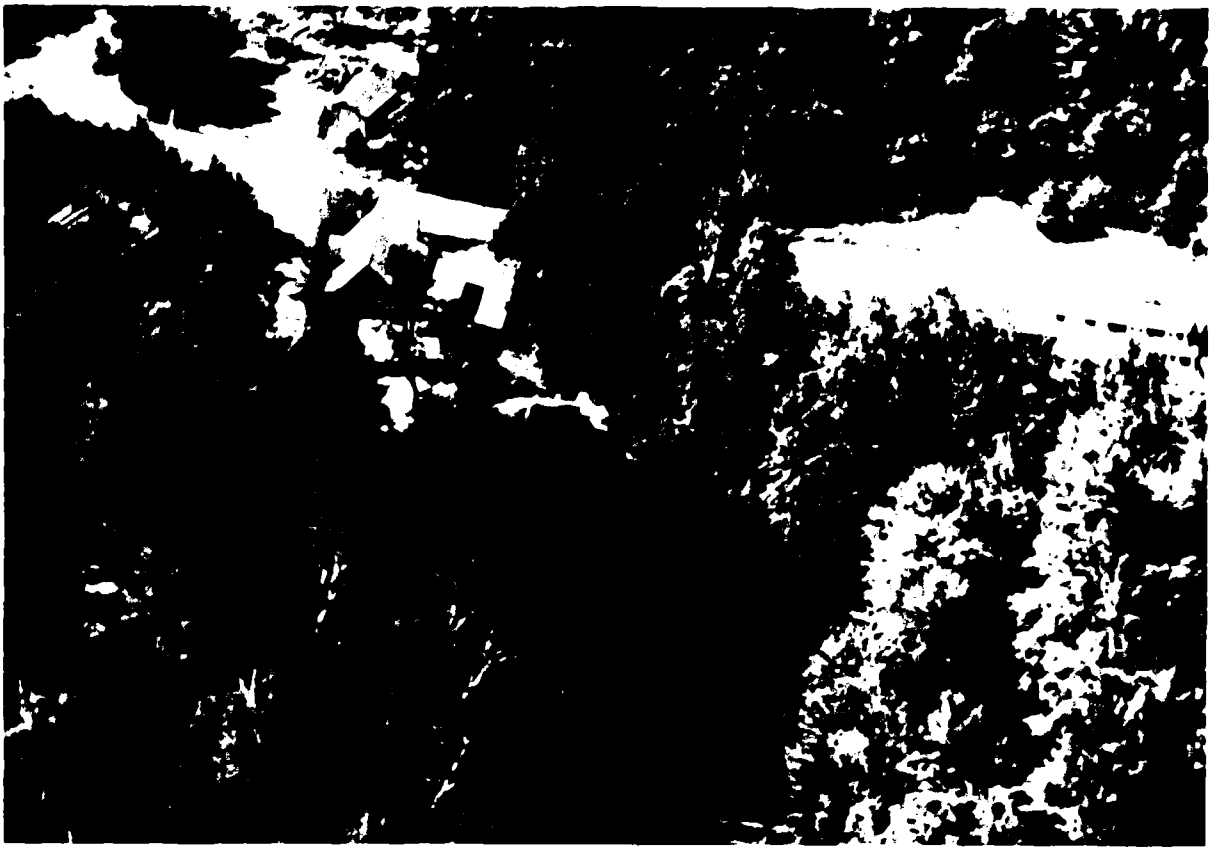
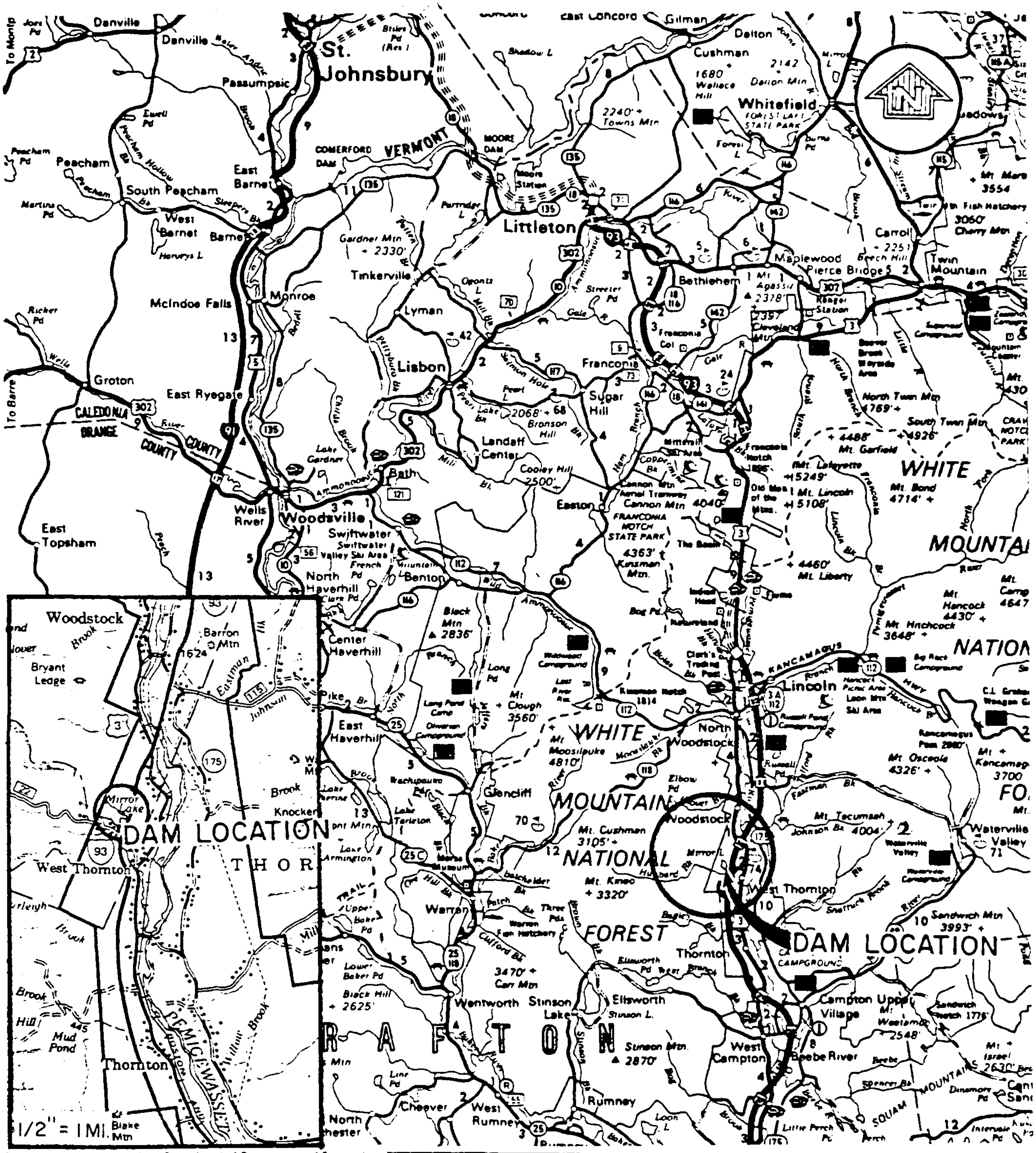


July 10, 1980

Photo 1 - Overview of Mirror Lake Dam.
Note remains of old timber crib dam in foreground.



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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MIRROR LAKE DAM LOCATION MAP

TRIBUTARY TO HUBBARD BROOK NEW HAMPSHIRE

SCALE: SEE BAR SCALE

DATE: AUGUST 1980

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
MIRROR LAKE DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of March 22, 1979, from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Mirror Lake Dam , also known as the Lower Dam, is located approximately 3 miles south of Woodstock, New Hampshire. The dam impounds Mirror Lake, a reservoir of small size. Water discharging over the dam flows south for about 1500 feet before its confluence with Hubbard Brook which empties into the Pemigewasset River another 2 miles southeast from this point. The Pemigewasset River is a major tributary in the Merrimack River Basin. The dam is shown on USGS Quadrangle, Plymouth, New Hampshire with coordinates approximately at N 43° 56' 30", W 71° 41' 30", Grafton County, New Hampshire. (See Location Map, page vi.)

b. Description of Dam and Appurtenances. Mirror Lake Dam is a concrete gravity dam containing two stoplog spillway bays with earth embankments extending to the east and west of the concrete structure. The dam is founded on ledge and has a

hydraulic height of 11.5 feet and a total length of about 290 feet. The east earth embankment is about 117 feet long with a crest width of about 13 feet. The upstream face has a gradual slope of approximately 2H:1V and consists of sand which changes to grass near the crest. The downstream face consists of a vertical dry stone masonry wall. Along the centerline of the crest is a footpath that extends the length of the east embankment. Both large and small trees are growing on the embankment. The west earth embankment has an average crest width of about 15 feet and is approximately 159 feet long. From the west concrete training wall of the spillway structure, the embankment extends west about 30 feet before changing in alignment to a more northerly direction. The slope of the upstream face is approximately 2H:1V and is covered with trees and brush. A cleared footpath extends the length of the west embankment along the centerline of the crest. The downstream face is composed primarily of a vertical dry stone masonry wall. Trees and brush are growing in and around this wall.

The concrete structure housing the two stoplog spillway bays is located between the earth embankments. The clear dimensions of the east bay are 5'W x 8.6'H while those of the west bay are 5'W x 3.8'H. Each bay utilizes 4" x 8" x 5'7" stoplogs. Water flowing over the stoplogs of the east bay enters a concrete stilling basin, 5'W x 12'L, before discharging over a V-notched metal plate weir that traverses the downstream end of the basin. Water passing over the stoplogs of the west bay flows along a 5'W x 6'L horizontal concrete section before it flows over a 5'W x 3'L concrete spillway with a slope of 1H:1.6V. From here the water enters a 5'W x 4'L concrete stilling basin prior to being discharged over a V-notched metal plate weir located across the downstream end of the basin. Both bays empty into the same channel downstream. The channel has drystone masonry training walls that extend 100 feet downstream to the Mirror Lake Road crossing. Separating the two stoplog bays is a 1.5-foot-wide concrete buttress. A concrete walkway, 11.5'W x 5'L covering the stoplog bays extends from the east to the west training wall. Protruding perpendicularly from the east training wall is an easterly direction is a concrete core wall whose surface is flush with the top of the east earth embankment. The core wall continues in this direction for 4 feet before changing in alignment in a northeasterly direction for 10 feet. Extending perpendicular from the upstream face of the west training wall in a westerly direction is a 26-foot-long concrete retaining wall that protects and supports the upstream side of the west earth embankment in the area near the stoplog spillways. On the upstream face of the retaining wall is a Type F - Stevens drum recorder that was installed in the summer of 1970 by the U.S. Forest Service to measure the stage continuously at the outlet.

c. Size Classification. Small (hydraulic height - 11.5 feet; storage - 750 acre-feet) based on storage ($\geq$50 to $<$1000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant based on the Recommended Guidelines for Safety Inspection of Dams. Dam failure was assumed most likely to occur along the earth embankments but it was difficult to determine which of the two embankments was more susceptible to failure. Therefore two breach analyses were performed; one for the east and one for the west earth embankments. The analysis which resulted in the most damage downstream was used to determine the hazard classification. For computational purposes the elevation of the top of the stoplogs in each stoplog bay was assumed to be 695.0' NGVD (i.e. stoplogs were assumed to be in place).

Results indicated that should the west earth embankment fail there would be a total flow of 1,953 cfs at Mirror Lake Road located 100 feet downstream of the dam. Prior to the breach the flow at the road was calculated to be 73 cfs. Dam failure would increase the water level by 6.8 feet which would cause the road to be overtopped by 3.3 feet. It is estimated that the Camp Osceola building, located in the area between the dam and the road, and the uninhabited shed situated directly across the road from the Camp Osceola building would also be inundated by approximately 3 feet of water. What is referred to above as the Camp Osceola building is a house which is occupied year round. Its facilities are utilized by vacationers and the like; therefore the number of people occupying the building at any particular time is quite variable.

The dam failure analysis for the east earth embankment suggests that the depth of flow associated with the breach discharge of 550 cfs would overtop Mirror Lake Road by 1.7 feet. In this case the Camp Osceola building and the uninhabited shed would be inundated by approximately 2 and 1.5 feet of water respectively.

Based on these results, it was concluded that regardless of which earth embankment is assumed to fail, there is the potential for appreciable property damage and the loss of less than a few lives. For these reasons, Mirror Lake Dam was considered a Significant Hazard.

e. Ownership. No records were found regarding the original owner of the dam. The dam is believed to have been built in 1836. However, records on file at the New Hampshire Water Resources Board (NHWRB) indicate that Mr. H.D. Emmons of Littleton, New Hampshire owned the dam as of 1936. In 1960 Mr. Warren Priest acquired Mirror Lake Dam from Mr. Emmons. In 1964, the NHWRB, who is the current owner, acquired the rights and easements to the dam from Mr. Priest.

f. Operation. Mr. Vernon K. Knowlton, Chief Engineer, New Hampshire Water Resources Board (NHWRB), 37 Pleasant Street, Concord, New Hampshire 03301, is responsible for the operation of Mirror Lake Dam. Phone: (603) 271-3406.

g. Purpose of Dam. Mirror Lake Dam was used for storage and recreation. At the present time it is being used primarily for recreation.

h. Design and Construction History. (Information was obtained from the files of the NHWRB.) Records indicate that Mirror Lake Dam was originally constructed about 1836. The concrete portion of the dam was not added until 1913. A sketch of the dam dated August 17, 1936 indicates that at this time the dam consisted of a 47-inch wide concrete sluice with concrete training walls and earth embankments on each side.

In 1964, when the NHWRB took over ownership, funds were allocated to reconstruct Mirror Lake Dam. Work was performed by the New Hampshire Fish and Game Department construction crew. Three sheets of design plans were found pertaining to this reconstruction effort. The spillway capacity of the dam was increased by converting the original concrete sluice to a stoplog bay and by adding another stoplog spillway bay next to the converted bay. New training and wingwalls were constructed on the east side while the walls on the west side along with the earth embankments were reconstructed. Also, a concrete core wall and a concrete retaining wall, extending into the earth embankments from the east and west training walls were constructed. A concrete pad extending from the east to the west concrete training wall, which serves as a walkway over the stoplog bays, was also added at that time.

i. Normal Operating Procedures. Removal or adding of stoplogs in either or both bays effects regulation of the level of Mirror Lake. The west bay is 5'W x 3.8'H and the east bay is 5'W x 8.6'H. Since the drainage basin is so small (0.34 square miles), the NHWRB has not instituted a regular fall drawdown - summer storage program for Mirror Lake. Consequently, the elevation of the stoplogs in each bay is not adjusted on a regular basis. Only infrequently and on an as needed basis are stoplogs added or removed. A maintenance staff member of the NHWRB visits the dam about once every 3 weeks. At this time, conditions at the dam are checked and recorded in a maintenance log. Maintenance is on an as needed basis. Minor maintenance, such as clearing debris from the dam, is also performed occasionally by Mr. Warren Priest, the owner of the Camp Osceola building located directly downstream of the dam, and members of the U.S. Forest Service who frequently collect readings from the gage located on the west concrete retaining wall.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 0.34 square miles (218 acres) of mountainous, predominantly wooded terrain. The normal recreational surface area of Mirror Lake is 37 acres which constitutes 17 percent of the watershed. There are no significant storage areas in the upstream watershed.

b. Discharge at Damsite

(1) Outlet works - None

(2) Maximum discharge at damsite is unknown.

(3) Ungated spillway capacity at top of dam - not applicable

(4) Ungated spillway capacity at test flood elevation - not applicable

(5) Gated spillway capacity at top of dam elevation -
73 cfs @ 696.7' NGVD (with stoplogs @ 695.0' NGVD)
398 cfs @ 696.7' NGVD (without stoplogs)

(6) Gated spillway capacity at test flood elevation -
82 cfs @ 697.3' NGVD (with stoplogs @ 695.0' NGVD)

(7) Total spillway capacity at test flood elevation -
82 cfs @ 697.3' NGVD (with stoplogs @ 695.0' NGVD)

(8) Total project discharge at top of dam -
73 cfs @ 696.7' NGVD (with stoplogs @ 695.0' NGVD)
398 cfs @ 696.7' NGVD (without stoplogs - assuming no tailwater conditions)
7 cfs @ 696.7' NGVD (natural saddle)

(9) Total project discharge at test flood elevation -
105 cfs @ 697.3' NGVD (with stoplogs @ 695.0' NGVD)
70 cfs @ 697.3' NGVD (natural saddle)

c. Elevation (ft. above NGVD: see (6) below)

(1) Streambed at toe of dam - 685.2

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 695.0

(5) Full flood control pool - not applicable

(6) Spillway crest (gated) - 695.0 (shown on USGS Quadrangle and assumed to be the elevation at the top of the stoplogs)

(7) Original design surcharge - unknown

(8) Top of dam - 696.7

(9) Test flood pool - 697.3 (with stoplogs @ 695.0)

d. Reservoir (length in feet)

(1) Normal pool - 2100

(2) Flood control pool - not applicable

(3) Spillway crest pool - 2100

(4) Top of dam - 2260

(5) Test flood pool - 2320

e. Storage (acre-feet)

(1) Normal pool - 677

(2) Flood control pool - not applicable

(3) Spillway crest pool - 677

(4) Top of dam - 750

(5) Test flood pool - 779

f. Reservoir Surface (acres)

(1) Normal pool - 37

(2) Flood control pool - not applicable

(3) Spillway crest - 37

(4) Test flood pool - 52

(5) Top of dam - 51

g. Dam

(1) Type - concrete gravity with stoplog spillway structure and earth embankments

(2) Length - 290'

(3) Structural height - 13'

(4) Top width - east earth embankment - 13';
west earth embankment - 15';
concrete stoplog spillway structure - 5'

(5) Side slopes - east earth embankment; 2H:1V upstream; vertical downstream: west earth embankment; 2H:1V upstream; vertical downstream: east stoplog spillway bay; vertical upstream and downstream: west sloplog spillway bay; vertical upstream; vertical immediately downstream of stoplogs followed by a concrete sluice of slope 1H:1.6V.

(6) Zoning - unknown

(7) Impervious core - unknown in original dam; In 1964, a 14 foot concrete core wall was added in the east embankment. Its depth is unknown.

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable

i. Spillway

(1) Type - stoplog with two bays

(2) Length of weir - 5' per stoplog bay; 10' total

(3) Crest elevation - 695.0' NGVD

(4) Gated - Two concrete stoplog spillway bays located next to each other between two earth embankments. The clear dimensions of the east stoplog bay are 5'W x 8.6'H while those of the west bay are 5'W x 3.8'H. The elevations of the inverts of the east and west bays are 688.1' NGVD and 692.9' NGVD, respectively.

(5) Upstream Channel - The upstream approach channel to the dam is actually a small oblong shaped bay of Mirror Lake that is about 210 feet long and 140 feet wide. The channel bottom consists of sand and gravel. The west bank of the bay is heavily wooded. The east bank is used for beaching canoes and consists of sand and grass. About 210 feet upstream of the dam is the entrance to the bay from the main body of Mirror Lake. The entrance constricts to a width of about 35± feet and is approximately 5 feet deep at its midpoint. Traversing the entrance are the submerged ruins of an old timber dam, which was formerly called the Upper Dam.

(6) Downstream Channel - Immediately downstream of the stoplog spillways the channel is about 15 feet wide with vertical dry stone masonry training walls and a channel bottom composed of boulders, with some sand and gravel. The channel retains these characteristics until it intersects Mirror Lake Road approximately 100 feet downstream of the dam. Here the water must flow through a 3-foot-diameter corrugated metal pipe traversing under the road. Approximately 1400 feet downstream of the road the channel joins with Hubbard Brook which eventually flows into the Pemigewasset River another 2 miles southeast from the channel - Hubbard Brook confluence.

j. Emergency Spillway

(1) Type - Natural saddle located approximately 400 feet northwest of the stoplog spillway section of the Mirror Lake Dam.

(2) Length of weir - The horizontal middle section of the natural saddle is about 30 feet long. Extending from the east end of this section the saddle assumes a positive slope of about 10H:1V for a horizontal distance of about 20 feet. Extending west from the west end of the flat section, for a horizontal distance of 25 feet, the saddle has an upward slope of 4H:1V.

(3) Crest elevation - Rocks and boulders form the crest of the saddle. The elevation of the horizontal section is about 696.5' NGVD.

(4) Gates - not applicable

(5) Upstream Channel - The upstream channel is approximately 80 feet wide with weeds and trees growing along the channel bottom and overbanks.

(6) Downstream Channel - The downstream channel is approximately 80 feet wide with weeds and trees growing along the channel bottom and overbanks. Flow through this saddle would intersect Mirror Lake Road approximately 300± feet downstream of the saddle crest. This is about 400± feet west of where the flow from the dam crosses the road. A series of one foot diameter corrugated metal pipes at this location would normally route the flow under the road. At the time of inspection, however, most of these pipes were plugged with debris so it is very likely that, unless the pipes are cleared, the water would pass over the top of Mirror Lake Road. From here the water would flow southeast through a wooded area and eventually combine with the flow from the dam.

k. Regulating Outlets - not applicable

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were found for Mirror Lake Dam. However, three (3) sheets of design plans were found for the reconstruction of the dam in 1964. The plans were designed and drawn by the New Hampshire Water Resources Board (NHWRB). Blueline copies are on file at the NHWRB and reduced copies can be seen in Appendix B.

2.2 Construction

No information was found regarding the original construction of the dam except an indication that it was constructed about 1836 with the concrete portion being added in 1913. A sketch of the dam, found in the files of the NHWRB and dated August 17, 1936, indicated that at this time the dam consisted of a 47-inch wide concrete sluice with concrete training walls and earth embankments on each side. In 1964, the NHWRB took over ownership and was allocated funds to reconstruct the dam. Visual inspection confirmed that the spillway capacity of the dam was increased by converting the original concrete sluice to a stoplog bay and by adding another stoplog bay next to the converted bay. New training and wing walls were constructed on the east side while the walls on the west side along with the earth embankments were reconstructed. In addition, a concrete core wall and a concrete retaining wall, extending into the earth embankments from the east and west training walls respectively, were constructed. Also, a concrete walkway extending from the east to west training wall covering the stoplog bays was added at that time.

2.3 Operation

No engineering operational data were found.

2.4 Evaluation

a. Availability. A search of the files of the NHWRB revealed only the plans for the reconstruction of the dam in 1964 and some general information.

b. Adequacy. Because of the limited amount of detailed data available, the final assessments and recommendations of this investigation are based on the visual inspection, hydrologic and hydraulic analysis, and the 1964 reconstruction plans.

c. Validity. The plans found in the files of the NHWRB are in general conformity with the structure as seen during the visual inspection.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Mirror Lake Dam is a low dam which impounds a reservoir of small size. The watershed above the reservoir is steeply sloping and wooded. The downstream area is generally flat in the Hubbard Brook and Pemigewasset River valleys.

b. Dam. Mirror Lake Dam is an earth dam about 290 feet long with a hydraulic height of 11.5 feet. The east earth embankment is approximately 117 feet long with a crest width of approximately 13 feet. A footpath, free of vegetation, extends along the crest. Many large and small trees and some brush are growing on the embankment. (See Appendix C - Photos 2 and 3.) The upstream face is inclined at about 2H:1V and consists of sand which changes to grass near the crest. A portion of the sandy area is used to beach canoes. The downstream face consists of a vertical dry stone masonry wall. (See Appendix C - Photos 4 and 5.) The downstream toe area between the concrete stoplog spillway and the east earth embankment consists partly of bedrock and partly of mowed lawn between the dam and the Camp Osceola building which sits on the east side of the downstream channel. (See Appendix C - Photo 5.) The west earth embankment has a crest width of about 15 feet and a length of approximately 159 feet. It also has a footpath clear of vegetation and an upstream face that is sloped at approximately 2H:1V. (See Appendix C - Photo 6.) Many trees and some brush are growing on the embankment; however, near the end of the embankment there is an area relatively free of vegetation where some erosion has occurred. The downstream face consists of a vertical dry stone masonry wall. A significant bulge where 2 large birch trees are growing exists in the wall where the earth embankment curves from a westerly to a more northerly direction. (See Appendix C - Photo 7.) Near the northerly toe of this bulge in the stonewall is a soft, wet area that is covered with trees and brush. (See Appendix C - Photo 8.)

A low area in the form of a natural saddle is located approximately 400± feet northwest of the concrete stoplog spillway structure. A stonewall forms the crest of the saddle. Trees and brush are growing along the upstream and downstream channel of the saddle. (See Appendix C - Photo 9.)

Inspection reports dated 1939 and 1969 indicate that the foundation of the dam is bedrock. This statement could not be confirmed on the basis of the visual inspection alone, although, as noted above, there were bedrock exposures immediately downstream of the dam between the spillway and the east embankment. Both embankments of the dam appear to be soil.

Leaks were mentioned in inspection reports dated 1936 and 1946. No flowing leakage was observed during the present inspection (although, as noted above, the downstream-toe area was wet and soft between the spillway and the west embankment), but it is pertinent to note that the dam was rebuilt in 1964, after the two dates on which leakage was reported.

c. Appurtenant Structures. A concrete spillway structure housing two stoplog spillway bays is located between the two earth embankments. (See Appendix C - Photos 10 and 11.) Extending from the east training wall of this structure into the east earth embankment is a 14 foot long, 1-foot-wide concrete core wall. The depth of this core wall could not be determined. Starting from the west training wall a 1 foot wide, 26 foot long, concrete retaining wall extends along the upstream face of the west earth embankment. (See Appendix C - Photo 10.)

Both stoplog bays utilize 4" x 8" x 5'-7" stoplogs. The condition of the stoplogs was observed to be good with no indication of deterioration.

The east stoplog bay is approximatley 5'W x 8.6'H. (See Appendix C - Photo 11.) Water flowing over the stoplogs of the east bay enters a 5'W x 12'L concrete stilling basin before discharging over a V-notch metal plate weir traversing the downstream end of the stilling basin.

The west stoplog bay is approximately 5'W x 3.8'H. Water passing over the stoplogs of the west bay flows along a 5'W x 6'L horizontal concrete section before flowing down a 5'W x 3'L concrete spillway inclined at 1H:1.6V. From here the water enters a 5'W x 4'L concrete stilling basin prior to being discharged over a V-notch metal plate weir located across the downstream end of the basin.

The bays are separated by a 1.5-foot-wide concrete buttress and are covered by an 11.5'W x 5'L concrete walkway. (See Appendix C - Photo 11.) The general condition of the concrete throughout the entire spillway structure was observed to be good. No spalling, cracks, or unusual seepage was apparent. The only rust that was observed was on the embedded concrete sections and on the surface of the V-notch metal plate weirs. (See Appendix C - Photos 11 and 12.)

There is a 2-inch diameter drain pipe near the base of the west side of the concrete spillway structure. According to the design plans this is a weeper pipe. The drain appears tc be functioning satisfactorily. Water was discharging from the drain at the time of the inspection and the concrete was rust-stained below the pipe. (See Appendix C - Photo 12.)

d. Reservoir Area. The watershed above the reservoir is steeply sloping and wooded. No evidence of significant sedimentation was observed. The approach channel to the dam constricts to a width of 35± feet and a maximum depth of about 5 feet, where the channel leaves the main body of the lake approximately 210 feet upstream from the spillway structure. Traversing the channel at the constriction are the submerged ruins of an old timber crib dam. (See Appendix C - Photos 1 and 13.)

e. Downstream Channel. A 3-foot diameter corrugated metal pipe traversing under Mirror Lake Road is located about 100 feet downstream from the dam. Between the dam and the road, are dry-stone-masonry training walls on either side of the channel. (See Appendix C - Photo 14.) Trees overhang the channel. The channel bottom is covered with boulders, gravel, and sand.

3.2 Evaluation

Based on the visual inspection, Mirror Lake Dam is in poor condition.

Trees and brush are growing on the embankment and could result in serious seepage or erosion problems if a tree blows over and pulls out its roots, or if a tree dies or is cut and its roots rot.

Some erosion has occurred on the upstream slope near the west embankment where there is no vegetation, apparently due to trespassing. Near the east embankment the upstream slope consists of a sandy beach, bare of vegetation, where canoes are beached. On the crest of the dam is a footpath which is bare of vegetation. Erosion caused by overflowing water resulting from rainfall or overtopping of the dam could cause the dam to breach if adequate erosion protection is not provided.

A major bulge in the dry-stone-masonry wall which retains the downstream side of the dam indicates that the wall may be failing. If the wall fails, the entire embankment may fail. Large birch trees growing out of this wall could also cause the wall to fail if they should blow over.

A large soft, wet area at the downstream toe where the west embankment curves northward indicates that significant seepage is occurring through the dam or its foundation. This seepage could result in a piping failure of the dam if the foundation or embankment consist of soils that are susceptible to piping.

Trees overhanging the discharge channel between the dam and the Mirror Lake Road culvert about 100 feet downstream of the dam could plug the culvert if they were undermined or blown over during flood-flow conditions.

A pile of cut brush on the downstream side of the dam near the west embankment makes it impossible to inspect that area adequately.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. According to New Hampshire Water Resources Board (NHWRB) personnel, no regular fall drawdown-summer storage program exists for Mirror Lake since its drainage basin (0.34 square miles) is so small. Consequently the stoplog elevations in each bay are adjusted infrequently and only on an as needed basis.

b. Description of Any Warning System in Effect. No warning system presently exists for Mirror Lake Dam.

4.2 Maintenance Procedures

a. General. The NHWRB is responsible for the maintenance of the dam. A maintenance staff member of the NHWRB visits the dam about once every 3 weeks to clear debris and check the overall condition of the dam. In addition, Mr. Warren Priest, the owner of Camp Osceola located directly downstream of the dam, and personnel from the U.S. Forest Service, who installed and utilize the gage on the west concrete retaining wall, also clear debris from the dam occasionally.

b. Operating Facilities. Maintenance is on an as needed basis.

4.3 Evaluation

The present operational and maintenance (O&M) procedures are adequate to ensure that minor problems encountered are remedied within a reasonable amount of time. However, in the event of a major problem or emergency situation the existing O&M procedures are not considered adequate. Deficiencies include: 1) the lack of an adequate surveillance program and warning system for those downstream, especially the occupants of the Camp Osceola building; 2) the absence of contacts in the immediate vicinity of the dam who could check the condition of the dam on a more continuous basis and notify the NHWRB if the dam warranted attention and; 3) the lack of a readily apparent means to quickly remove the stoplogs to increase the spillway discharge capacity and lower the level of the lake during periods of highwater.

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General

Mirror Lake Dam is a concrete gravity dam containing two stoplog spillway bays with earth embankments extending to the east and west of the concrete structure. Total length of the dam is about 290 feet with a hydraulic height of 11.5 feet. The dam impounds Mirror Lake, a reservoir of small size, which accepts runoff from a 0.34 square mile drainage basin characterized by a predominantly wooded mountainous terrain. No significant storage areas exist in the upstream watershed. The clear opening of the east stoplog bay without stoplogs is approximately 5'W x 8.6'H while the shallower west bay is 5'W x 3.8'H. A concrete walkway 11.5'W x 5'L covers the stoplog bays. The east earth embankment is approximately 117 feet long with a crest width of about 13 feet. The west earth embankment has a 15 foot average crest width and a length of about 159 feet. From the west concrete training wall of the spillway structure, the embankment extends west 30 feet before changing in alignment to a more northerly direction. Vertical dry-stone-masonry walls support the downstream face of both embankments while the upstream faces are composed of sand or sandy soil with a slope of approximately 2H:1V. Trees and brush are growing on both embankments. A concrete core wall projects from the east concrete training wall about 14 feet along the centerline of the east earth embankment. On the west side, starting from the west concrete training wall, a 26 foot long concrete retaining wall extends along the upstream face of the west earth embankment.

5.2 Design Data

No hydrologic/hydraulic criteria used in the design of Mirror Lake Dam were found.

5.3 Experience Data

At the time of the inspection, no visual evidence of damage to the dam caused by excessive discharges were noted.

5.4 Test Flood Analysis

Mirror Lake Dam is classified as being small in size having a hydraulic height of 11.5 feet and a maximum storage capacity of 750 acre-feet. The dam was determined to have a significant hazard classification. In accordance with the Recommended Guidelines for Safety Inspection of Dams, the test flood may range from the 100-year to ½ the Probable Maximum Flood (PMF). Because a breach of the dam poses a threat to the lives of those downstream, especially to the occupants of the Camp Osceola building located only 40± feet directly downstream of the east earth embankment, the test flood was chosen to be ½PMF.

Using the PMF Peak Flow Rates graph provided by the Corps, the peak inflow for this watershed, having a drainage area of 0.34 square miles and a slope which qualifies the basin as "mountainous", was determined to be 867 cfs (2550 csm). Therefore the test flood inflow for ½PMF would be 434 cfs (1275 csm). Using the procedure outlined in Estimating Effects of Surcharge Storage on Maximum Probable Discharges issued by the Corps to determine the modifying effect of surcharge storage on the test flood inflow, the routed test flood outflow was determined to be 175 cfs @ 697.3' NGVD. This is assuming that the stoplogs are in place up to an elevation equal to 695.0' NGVD which was their elevation at the time of inspection. It was decided to use this stoplog elevation after consultation with New Hampshire Water Resources Board (NHWRB) personnel revealed that stoplogs are infrequently added or removed.

The test flood analysis indicates that the dam would be overtopped by 0.6 feet. The maximum spillway capacity of the two stoplog bays at top of dam is 73 cfs which is 42 percent of the routed test flood outflow.

5.5 Dam Failure Analysis

The impact of failure of the dam with the reservoir level at top of dam was assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered only one reach which extended from the dam to Mirror Lake Road located approximately 100 feet downstream. Approximately 1400 feet downstream of the road the tributary flows into Hubbard Brook. No downstream hazard exists along this reach.

Dam failure was considered most likely to occur along the earth embankments but it was difficult to determine which of the two embankments was more susceptible to failure. Therefore two breach analyses were performed; one for the east and one for the west earth embankment. The analysis which resulted in the most damage downstream was used to determine the hazard classification. In the analysis the elevation of the stoplogs was assumed to be 695.0' NGVD which was their elevation at the time of inspection.

Results indicate that a breach of the west earth embankment with the water surface elevation at top of dam would result in a discharge of 1,953 cfs. The discharge through the two stoplog spillway bays just prior to failure would be 73 cfs. A breach would cause an increase in stage of 6.8 feet above the antecedent stage of 4 feet at Mirror Lake Road located 100 feet downstream of the spillway structure. The road would be overtopped along its lowest point to a depth of approximately 2.8 feet. In addition to the road, two building structures would also be flooded by about 3 feet of water, namely the Camp Osceola building located on the east side of the channel between the dam and the road and the uninhabited shed located across the road from the Camp Osceola building. The Camp Osceola building is a house which is occupied year round. Its facilities are utilized by vacationers

and the like; therefore the number of people occupying the building at any particular time is quite variable. Based on this analysis it was assumed that appreciable property damage and the possible loss of less than a few lives could occur if the west earth embankment were to fail.

A breach of the east earth embankment would result in a breach discharge of 550 cfs. This would cause the road to be overtopped by approximately 1.7 feet. In addition the Camp Osceola building and the uninhabited shed would be inundated by approximately 2.0 and 1.5 feet of water, respectively. The Camp Osceola building would probably receive the most damage of the two structures since it is located directly in the path of flow and only 40± feet downstream of the assumed breach section. The conditions resulting from a breach of the east earth embankment were considered sufficient to cause appreciable property damage with the potential for loss of less than a few lives.

The results of the two breach analyses therefore indicate that regardless of which earth embankment is assumed to fail, the outcome will be similar; appreciable property damage with a possible loss of less than a few lives. Mirror Lake was therefore classified a Significant Hazard.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual examination indicates the following potential structural problems:

(1) Trees and brush growing on the embankment could lead to seepage and erosion problems if a tree blows over and pulls out its roots or if a tree dies or is cut and its roots rot.

(2) Trespassing and minor erosion on the upstream slope and crest of the dam and lack of erosion protection make these areas subject to severe erosion. Erosion caused by overflowing water resulting from rainfall or overtopping of the dam could cause the dam to breach.

(3) A major bulge in the dry-stone-masonry wall which retains the downstream side of the west embankment indicates that the wall may be failing which could lead to failure of the entire embankment.

(4) Large birch trees growing in the dry-stone-masonry wall which retains the downstream side of the west embankment could cause failure of the wall and embankment if the trees are blown over and uprooted.

(5) A large soft, wet area at the downstream toe between the spillway and west embankment is an indication that seepage is taking place through the embankment or the foundation. This could lead to piping failure of the dam if the embankment or foundation consists of soils that are susceptible to piping.

6.2 Design and Construction Data

No design or construction data relative to the structural stability of the dam were found.

6.3 Post Construction Changes

Sketches of the dam for the reconstruction in 1964 indicate that the concrete spillway structure is founded on "ledge," but do not include any information about the character of the embankment fill or the foundation of the embankment.

6.4 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Mirror Lake Dam is in poor condition. The major concerns with respect to the integrity of the dam, if left uncorrected, are:

(1) Trees and brush growing on the embankment which could lead to seepage and erosion problems if a tree blows over and pulls out its roots or if a tree dies or is cut and its roots rot.

(2) Trespassing and minor erosion on the upstream slope and crest of the dam and lack of erosion protection make these areas subject to severe erosion. Erosion caused by overflowing water resulting from rainfall or overtopping of the dam could cause the dam to breach.

(3) A major bulge in the dry-stone-masonry wall which retains the downstream side of the west embankment indicates that the wall may be failing which could lead to failure of the entire embankment.

(4) Large birch trees growing in the dry-stone-masonry wall which retains the downstream side of the west embankment could cause failure of the wall and embankment if they blow over and are uprooted.

(5) A large soft, wet area at the downstream toe between the spillway and west abutment, indicating that seepage is taking place through the embankment or foundation, might lead to piping failure of the dam if the embankment or foundation consists of soils that are susceptible to piping.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection. A pile of cut brush on the downstream side of the dam near the west embankment made it impossible to inspect that area adequately.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

7.2 Recommendations

The owner should engage a registered professional engineer qualified in the design and construction of dams to:

(1) Specify and oversee procedures for the removal of trees and their root systems from the dam and a zone 25 feet wide at the downstream toe of the dam.

(2) Design repairs for the unstable dry-stone-masonry wall which retains the downstream side of the embankment.

(3) Investigate the soft, wet area at the downstream toe of the dam between the spillway and the west embankment and design remedial measures, if needed.

(4) Design repairs for erosion on the embankment and design erosion protection for the embankment.

(5) Perform detailed hydrologic and hydraulic studies to determine the need for and methods to increase project discharge capacity.

The owner should carry out the recommendations made by the engineers.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Cut brush on dam embankments and remove.

(2) Remove the pile of cut brush on the downstream side of the dam near the west embankment.

(3) Cut trees that overhang the discharge channel between the dam and the road downstream of the dam.

(4) Implement a means to facilitate the quick removal of stoplogs to increase the spillway capacity of the dam and lower the level of the lake during seasons of heavy rainfall.

(5) Visually inspect the dam and appurtenant structures once a month.

(6) Engage a professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(7) Establish a surveillance program for use during and immediately after heavy rainfall and also a downstream warning program to follow in case of emergency. A contact in the immediate vicinity of the dam should be established to enable the NHWRB to keep a continuous check on the dam's condition. Engineers at the NHWRB could then, in turn, direct any stoplog operations necessitated by the contact's input.

7.4 Alternatives

There are no practical alternatives to the recommendations and remedial measures given in Sections 7.2 and 7.3.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Mirror Lake Dam, NH

DATE July 9, 1980

TIME 1:00 PM

WEATHER Clear, warm

W.S. ELEV. U.S. 694.6 DN.S. 685.2

PARTY:

1. Warren Guinan (ANCo)
2. Stephen Gilman (ANCo)
3. Leslie Williams (ANCo)
4. Gregg Comstock (ANCo)
5. Ronald Hirschfeld (GEI)
6. Gary Kerr (NHWRB)
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	G. Comstock/L. Williams	
2.	Structural Stability	S. Gilman	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Mirror Lake Dam, NH DATE July 9, 1980

PROJECT FEATURE Dam Embankment NAME R. Hirschfeld

DISCIPLINE Soils & Geology NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	Unknown.
Surface Cracks	None observed.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None observed.
Lateral Movement	Dry-stone-masonry wall which retains downstream side of embankment between spillway and west embankment has bulged locally.
Vertical Alignment	Good.
Horizontal Alignment	See "Lateral Movement."
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	See "Lateral Movement."
Trespassing on Slopes	Footpath on crest. Canoe beaching area on upstream slope near east embankment.
Sloughing or Erosion of Slopes or Abutments	Area bare of vegetation and with minor erosion on upstream slope near east embankment.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or Near Toe	See "Lateral Movement."
Unusual Embankment or Downstream Seepage	Soft, wet area at downstream toe between spillway and west embankment.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None observed.
Vegetation	Trees and brush growing on crest, upstream slope, and downstream toe area, and two large trees growing in dry-stone-masonry wall which retains downstream side of west embankment.

PERIODIC INSPECTION CHECKLIST

PROJECT Mirror Lake Dam, NH DATE July 9, 1980

PROJECT FEATURE Control Tower NAME S. Gilman

DISCIPLINE Structural NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good.
Condition of Joints	Good. No indication of movement.
Spalling	None visible.
Visible Reinforcing	None apparent.
Rusting or Staining of Concrete	Only at embedded items.
Any Seepage or Efflorescence	None apparent.
Joint Alignment	Good.
Unusual Seepage or Leaks in Gate Chamber	None.
Cracks	None apparent.
Rusting or Corrosion of Steel	V-notch weirs are surface rusted.
b. Mechanical and Electrical	Not applicable.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Mirror Lake Dam, NH DATE July 9, 1980

PROJECT FEATURE Spillway Weir NAME R. Hirschfeld

DISCIPLINE Soils-Geology & Structural NAME S. Gilman

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Fair
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Trees overhand channel.
Floor of Approach Channel	Sand and gravel.
b. Weir and Training Walls	
General Condition of Concrete	Good.
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	None.
c. Discharge Channel	
General Condition	Fair.
Loose Rock Overhanging Channel	Dry-stone-masonry training walls on sides of channel.
Trees Overhanging Channel	Trees overhang channel.
Floor of Channel	Boulders, some sand and gravel.
Other Obstructions	Highway culvert about 100 ft. downstream of dam.
Stoplogs and Slots	Good - no indication of deterioration.

PERIODIC INSPECTION CHECKLIST

PROJECT Mirror Lake Dam, NH DATE July 9, 1980

PROJECT FEATURE Service Bridge NAME S. Gilman

DISCIPLINE Structural NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	Not applicable.
Anchor Bolts	Not applicable.
Bridge Seat	Not applicable.
Longitudinal Members	Good.
Underside of Deck	Good.
Secondary Bracing	Not applicable.
Deck	Good.
Drainage System	Not applicable.
Railings	Good.
Expansion Joints	None.
Paint	Good.
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

MEMO

TO KEN

FROM KEN

RE MIRROR LAKE WOODSTOCK 259.07
TREE REMOVAL

On 5/2/79 I inspected Mirror Lake dam in Woodstock. The right dike is overgrown with trees up to 24 inches in diameter. The left dike has about a half dozen mature trees growing on it. No seepage was detected.

The right ~~one~~ dike is posted against trespassing. I met Mr. JAMES LAMBREGTSE, RFD 1, Tampton. Mr L informed me that he is the owner of the land that the right dike is located on. He said his deed makes no mention of the dam. He is very much against cutting the trees from the dike. He said that he would not allow anyone to cut trees until he ~~was~~ is presented w/ court order forcing him to. He requested that we go to his house, the burnt out red one, before doing

anything.

The left dike appears to be owned by Warren Priest of Camp Osceola. I did not contact Mr Priest but assume he would also object to having his trees cut. The trees are mature and make the area very scenic.

The 1964 reconstruction plans specifically call for saving ~~~~ certain large trees and includes a special provision that no tree 6" or larger should be cut without permission from the engineer

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Woodstock Dam Number: 259.07

Inspected by: Francis C. Mac [illegible] Date: October 30 1969

Local name of dam or water body: Mirror Lake

Owner: State of N.H. - N.H. Water Resources Board Address: 216 State House Annex Concord, N.H. 03301

Owner was/was not interviewed during inspection.

Drainage Area: 0.43 sq. mi. Stream: Trib. Hubbard Brook

Pond Area: ~~37.1~~ Acre, Storage 100± Ac-Ft. Max. Head 9.2' Ft.

Foundation: Type Ledge, Seepage present at toe - Yes/No,

Spillway: Type Stop logs, Freeboard over perm. crest: 4.5' & 9.2',

Width 2-5' bays, Flashboard height None,

Max. Capacity c.f.s.

Embankment: Type, Cover Width,

Upstream slope to 1; Downstream slope to 1

Abutments: Type Earth, Condition: (Good,) Fair, Poor

Gates or Pond Drain: Size Only Stoplogs in two bays Capacity Type

Lifting apparatus Operational condition

Changes since construction or last inspection: Spillway Rebuilt by N.H.W.R.B in 1965.

Downstream development: Town Road immediately below & U.S. Hwy #3 - 1 mile down

This dam would/~~would not~~ be a menace if it failed.

Suggested reinspection date: 1974

Remarks:

MIRROR LAKE

Mirror Lake dam was rebuilt with funds from the Capital Budget for recreational development in September and October, 1964 at a cost of $ by the N. H. Fish and Game Department construction crew. Formerly, there was a diversion of water from Hubbard Brook to increase the flow for small manufacturing power. Rights and easements to the dam were acquired by the Water Resources Board.

Drainage Area: 0.43 square miles

Pond Area: 37.1 acres

1 inch runoff from drainage less pond area raised lake 6.15 inches.

15 year frequency flood flow: 100 cfs.

100 year frequency flood flow: 210 cfs.

Spillway (stop log sections - 5 feet wide):

Shallow section: 5 feet wide by 4½ feet deep

Deep section: 5 feet wide by 10½ feet deep

NOTE: Above sections have stop logs (when in place) from 2 feet below crest of dam to bottom.

Capacity of Stop Log Sections:

Head	Flow - cfs.
2"	1.1
4"	3.2
6"	5.7
9"	9.7
12"	16.
18"	29.
24"	43.5
30"	59.
36"	76.
48"	112.

June 21, 1946

Dam 280.07

Mirror Lake, Woodstock, N. H.

This dam was inspected on above date. The dam is in fair condition. There is an old leak under the dam which still persists. The construction and conditions of this dam is such that it will probably stand up under minor floods. If repairs are ever made to this dam, attempt should be made to obtain greater spillway capacity.

Leonard R. Frost
Engineer

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 259.07

Town Woodstock: County Grafton

Stream Mirror Lake

Basin-Primary Merrimack: Secondary Pemigewasset R.

Local Name Lower Dam

Coordinates—Lat. 43°55'48.800ft.: Long. 71°40'46.400

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 0.47 Sq. Mi.

Overall length of dam 300 ft.: Date of Construction 1836, concrete in 1913

Height: Stream bed to highest elev. 11 ft.: Max. Structure 9.5 ft.

Cost—Dam .....: Reservoir .....

DESCRIPTION Gravity, stone, earth, concrete on ledge

Waste Gates

Type .....

Number .....: Size ..... ft. high x ..... ft. wide

Elevation Invert .....: Total Area ..... sq. ft.

Hoist .....

Waste Gates Conduit

Number .....: Materials .....

Size ..... ft.: Length ..... ft.: Area ..... sq. ft.

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width .....: Elev. ..... ft.

Slopes—Upstream ..... on .....: Downstream ..... on .....

Length—Right of Spillway .....: Left of Spillway .....

Spillway

Materials of Construction concrete (Sluice)

Length—Total 3.917 ft.: Net ..... ft.

Height of permanent section—Max. 9.5 ft.: Min. ..... ft.

Flashboards—Type none: Height ..... ft.

Elevation—Permanent Crest .....: Top of Flashboard .....

Flood Capacity ..... cfs.: ..... cfs/sq. mi.

Abutments

Materials: .....

Freeboard: Max. 1.5 ft.: Min. ..... ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Harry Emmons, Littleton, NH.

REMARKS Condition fair-Leaks

Dam is Menace. Use-Recreation-Storage.

Tabulation By RLT Date 9/28/39

B&B21284

7205

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 259.07

Town Woodstock : County Grafton

Stream Mirror Lake

Basin—Primary Merrimack R. : Secondary Pemigewasset R.

Local Name Lower Dam

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total ..... Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards			
(3) Permanent Crest			
(4) Normal Drawdown		37.10	
(5) Max. Drawdown			
(6) Original Pond			

Base Used .....: Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	....ft.	....ft.
Volume	....ac. ft.	....ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Use-Recreation.Storage

OWNER Harry Emmons, Littleton, NH.

REMARKS Menace

Tabulation By RLT Date 9/28/39

Form E1A
4845

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5460

TOWN	WOODSTOCK	TOWN NO. 7	STATE NO.
RIVER STREAM	Mirror Lake		
DRAINAGE AREA		POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Stone, Earth, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	11'	TOP OF DAM TO SPILLWAY CRESTS	18"
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	3'-11"	LENGTH OF DAM	Approx. 00
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS			

REMARKS

OWNER: Harry Emmons - Littleton

CONDITION: Fair - (leaks)

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 14, 1936, according to notification to owner dated Aug. 5, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 20, 1936
Copy to Owner

No. .....

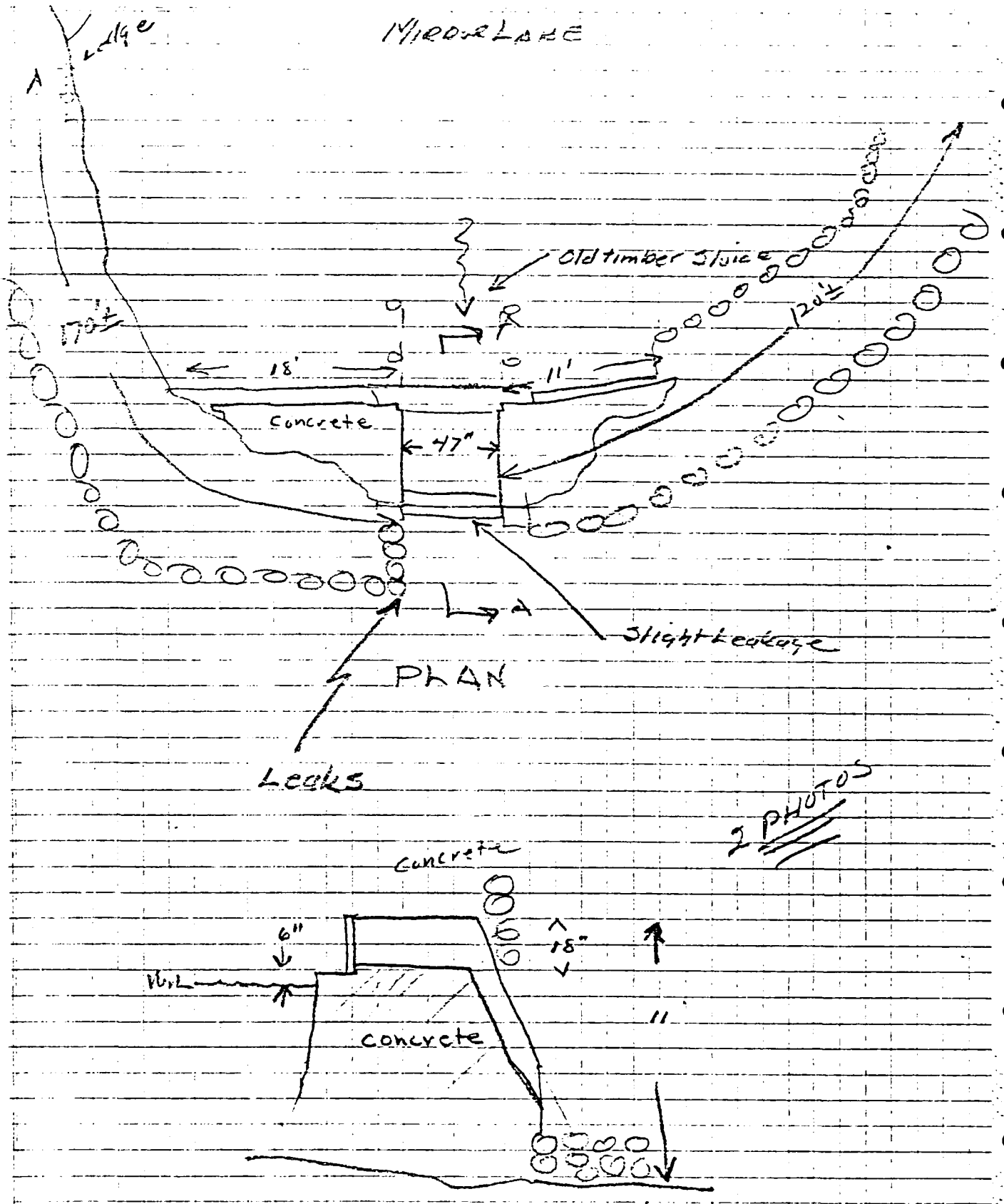
CALCULATION SHEET

Date Aug 17, 1936

Refers to .....

Made By .....

3646



NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Merrimack NO. 7- -I-5460
RIVER Mirror Lake MILES FROM MOUTH D.A.SQ.MI.
TOWN Woodstock OWNER Henry D. Emmons, Littleton &
LOCAL NAME OF DAM Lower Dam (Incl. Thornton Est.)
BUILT about 1836 DESCRIPTION Gravity — Stone, Earth, Concrete
(concrete part in 1913) on Ledge

POND AREA-ACRES 37.10 DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 11 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 304 MAX. FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV. U.S.G.S. LOCAL GAGE
TAILWATER ELEV. U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 209 FREEBOARD-FT. 1.5
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST None
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

REMARKS Conditions Fair Into Pemigewasset R.

SE. into Hubbard Br. Pemigewasset R.

Coordinates from A.E.
43° 55' + 8800 +
71° 40' + 6400 +

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

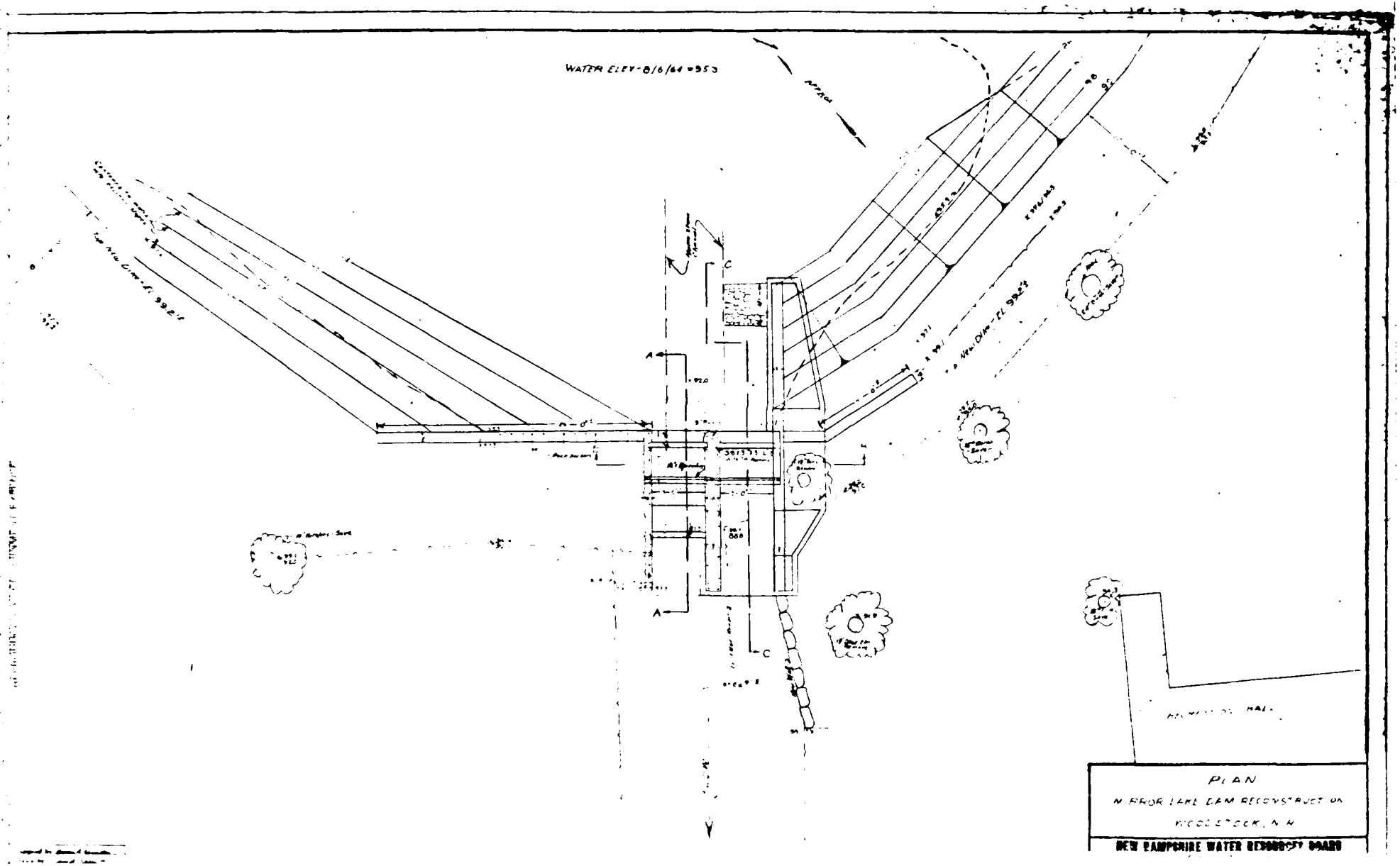
USE Recreation

REMARKS Menace Water right owned by Henry D. Emmons. Used by Exchange only. A.E. says another dam upstream 100 ft. not mentioned by PSC

7/31/36 AE.

DATE

SITE PLAN
MIRROR LAKE DAM RECONSTRUCTION
WOODSTOCK, N.H.
NEW HAMPSHIRE WATER RESOURCES BOARD
CONCORD, N.H.
1967
APPROX.
LOCATION PLAN
WOODSTOCK
ELLSWORTH
Camp Osceola
Recreation Building
Stockade Road
To West Thornton

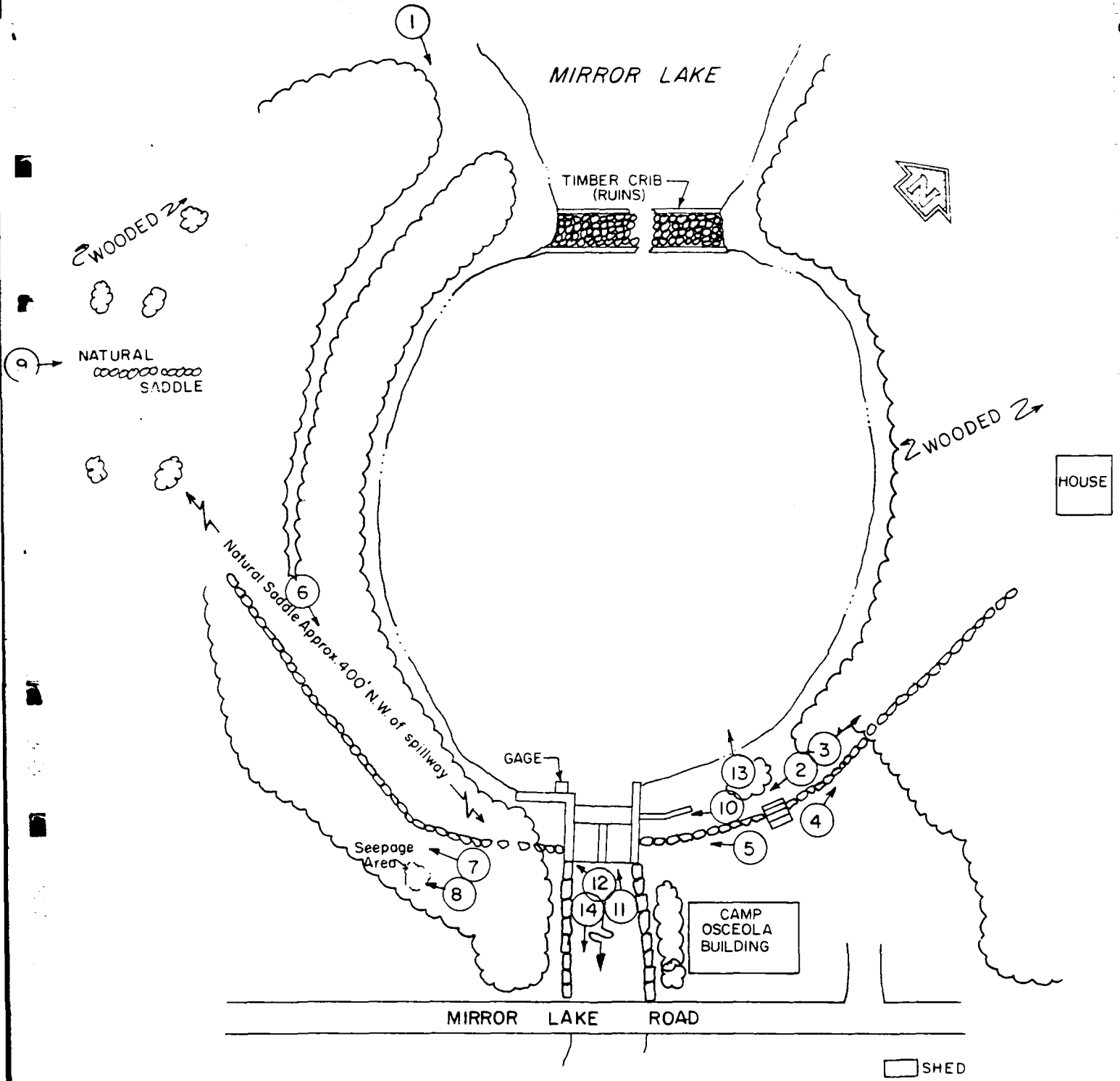

WATER ELEV-8/6/64 =953
PLAN
N. PRIOR LAKE DAM RECONSTRUCTION
WOODSTOCK, N. H.
NEW HAMPSHIRE WATER RESOURCES BOARD

SECTION A-A

NEW HAMPSHIRE WATER RESOURCES BOARD
CONCORD, N.H.

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co, Inc CONCORD NEW HAMPSHIRE	U.S ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MIRROR LAKE DAM
PHOTO INDEX

TRIBUTARY TO HUBBARD BROOK NEW HAMPSHIRE

SCALE NOT TO SCALE

DATE AUGUST 1980

July 9, 1980

Photo 2 - Looking west along crest of east earth embankment. Note the footpath and the trees on the embankment and the Camp Osceola building in the background.

July 9, 1980

Photo 3 - Looking east along the crest of the east earth embankment. Note footpath and trees.

July 9, 1980

Photo 4 - Looking at the downstream toe of the eastern end of the east earth embankment. Note the vertical dry-stone-masonry wall.

July 9, 1980

Photo 5 - View of the downstream toe of the western end of the east earth embankment next to the spillway. Note the vertical dry-stone-masonry wall.

July 9, 1980

Photo 6 - Looking south along the crest of the west earth embankment. Note footpath, trees, and brush.

July 9, 1980

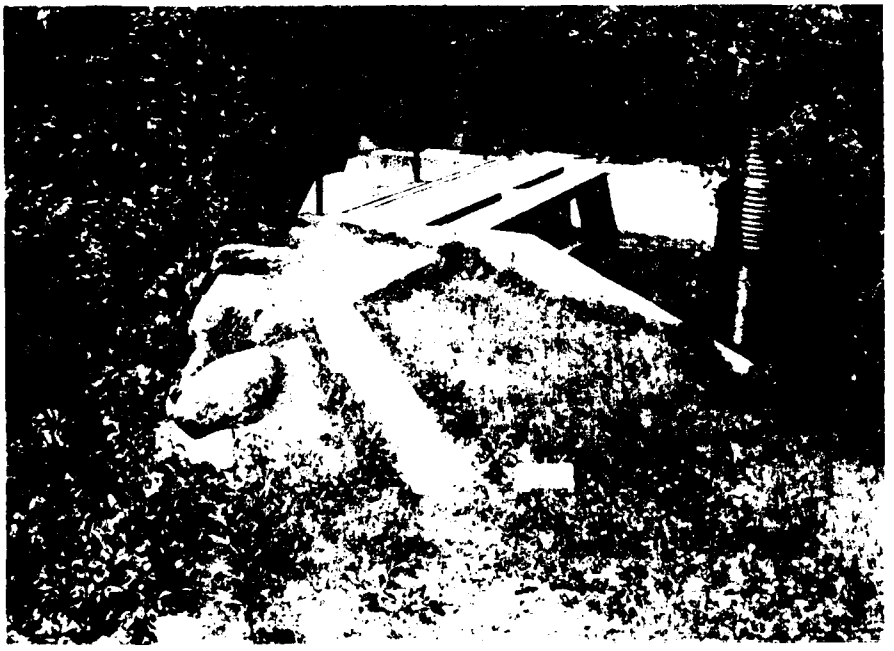
Photo 7 - View of the downstream toe of the west embankment where the embankment curves from a westerly to a northerly direction. Note bulge in dry-stone-masonry wall and birch trees growing out of the wall.

July 9, 1980

Photo 8 - View of soft, wet area at the downstream toe of the west earth embankment where the embankment curves from a westerly direction to a northerly one.

July 9, 1980

Photo 9 - View of natural saddle located approximately 400± feet northwest of the spillway structure of the dam.



July 9, 1980

Photo 10 - View from the east earth embankment looking west at the concrete spillway structure housing 2 stoplog spillway bays. Note concrete corewall.

July 9, 1980

Photo 11 - View of the 2 concrete stoplog spillway bays from the downstream channel.

July 9, 1980

Photo 12 - View of 2-inch diameter drainage pipe located at downstream toe of west training wall. Note staining of concrete below drainage pipe.

July 9, 1980

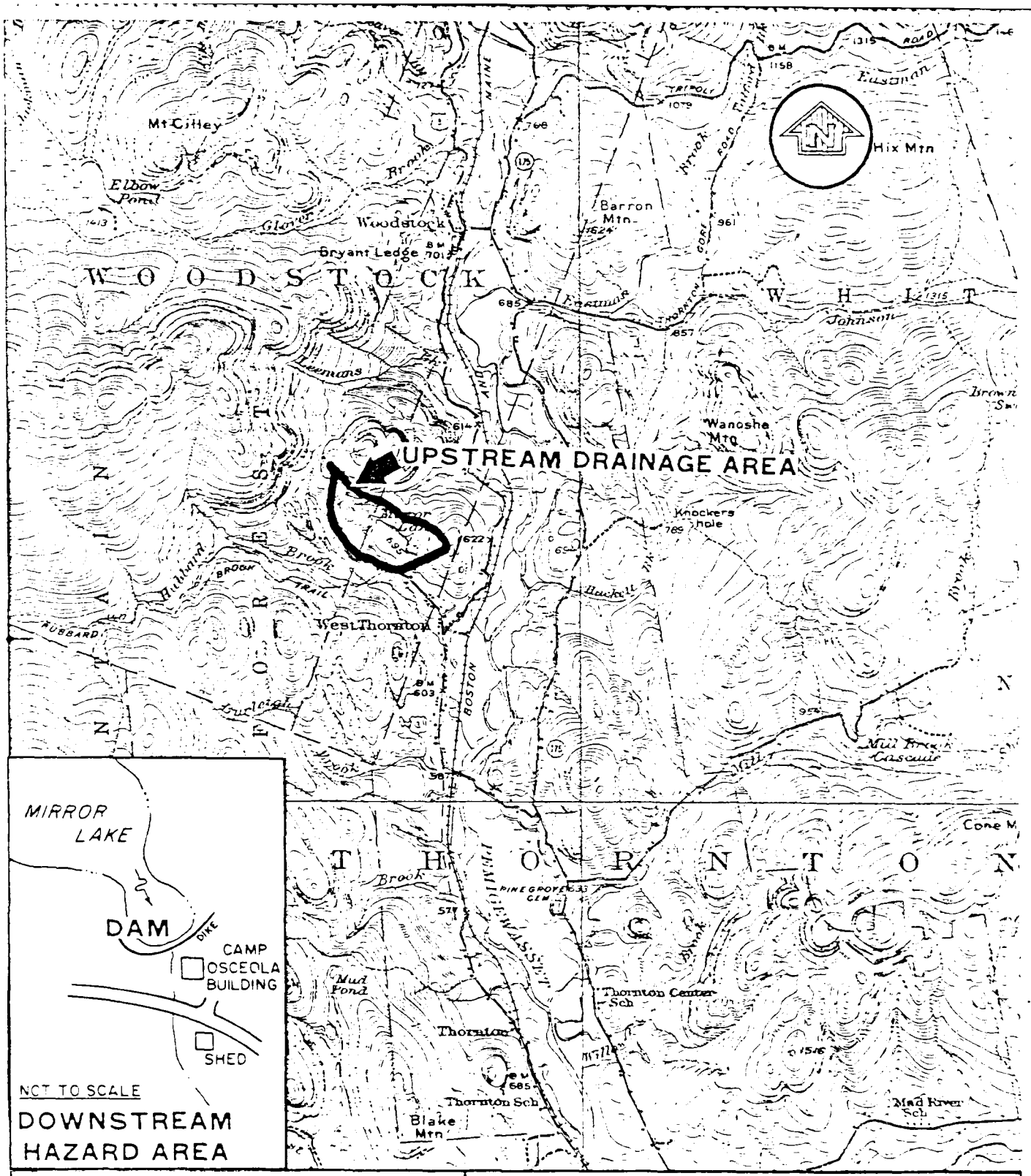
Photo 13 - View of upstream channel from east earth embankment. Note canoe beaching area in foreground and channel constriction in background.

July 9, 1980

Photo 14 - View of downstream channel from downstream toe of concrete stoplog spillway structure. Note vertical dry-stone-masonry walls, trees, and 3-foot diameter culvert beneath road located about 100 feet downstream.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

MIRROR LAKE DAM

WOODSTOCK, NEW HAMPSHIRE

REGIONAL VICINITY MAP

AUGUST 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, NH

MAP BASED ON U.S.G.S. 15 MINUTE QUADRANGLE SHEET, PLYMOUTH, N.H. 1928

BREACH ANALYSIS – ASSUME BREACH WITH WSEL AT TOP OF DAM (696.7' NGVD) TO DETERMINE D/S HAZARD POTENTIAL

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, y_o^{3/2}$$

W_b = BREACH WIDTH

g = 32.2 FT/SEC^2

y_o = POOL ELEV. AT TIME OF BREACH (696.7') MINUS THE U/S RIVER BED ELEV. WHERE THE BREACH IS OCCURRING.

NOTE: FOR MIRROR LAKE DAM, FAILURE WAS ASSUMED TO OCCUR ALONG THE EARTH EMBANKMENTS DOWN TO AN ELEV. EQUAL TO THAT OF THE D/S TOE OF THE DAM. "y_o" WAS THEREFORE CALCULATED USING D/S TOE ELEVATIONS INSTEAD OF U/S RIVER BED ELEVATIONS.

FOR MIRROR LAKE DAM: FAILURE WAS CONSIDERED MOST LIKELY TO OCCUR ALONG THE EARTH EMBANKMENTS. A SEPARATE BREACH ANALYSIS WAS PERFORMED FOR EACH OF THE TWO EARTH EMBANKMENTS THAT EXTEND FOR 100' FEET TO THE EAST AND WEST OF THE CONCRETE PORTION OF THE DAM. THESE TWO ANALYSES ARE LABELLED "CONDITION 1" AND "CONDITION 2" AND REFER TO THE WEST AND EAST EMBANKMENTS RESPECTIVELY.

CONDITION 1: BREACH OF WEST EARTH EMBANKMENT

BREACH WIDTH, W_B, WAS ASSUMED TO EXTEND 100 FT. WEST FROM THE WEST END OF THE CONCRETE CORE WALL.

W_B = 100 FT

"y_o" WAS MEASURED FROM THE TOP OF DAM (ELEV. 696.7' NGVD) TO THE D/S TOE ELEVATION. HOWEVER, THE D/S TOE ELEVATIONS VARY THROUGHOUT THE ASSUMED BREACH SECTION. A "WEIGHTED" y_o WAS THEREFORE CALCULATED.


MIRROR LAKE DAM
WEIR CROSS SECTION
7/11/80 CJG&C
705
700
695
690
685
ELEVATION (FT. NGVD)
TOP OF DAM = 696.7
TOP OF STOP LOGS = 695.0
EXTEND OF CONCRETE CORE WALL
RT. END OF CONCRETE RETAINING WALL
CREST OF DAM
D/S TOE OF DAM
0
50
100
150
200
250
300
350
400
450
DISTANCE (FT)

E-1

CONDITION 1 (CONTINUED)

CALCULATION OF "WEIGHTED y_o" :

$$\left[\frac{(696.7-689.6)+(696.7-690.5)}{2}\times 25' + \frac{(696.7-690.5)+(696.7-692.4)}{2}\times 25' + \frac{(696.7-692.4)+(696.7-692.3)}{2}\times 25' + \frac{(696.7-692.3)+(696.7-693.6)}{2}\times 25'\right] \div 100 = \boxed{5.0' = y_o}$$

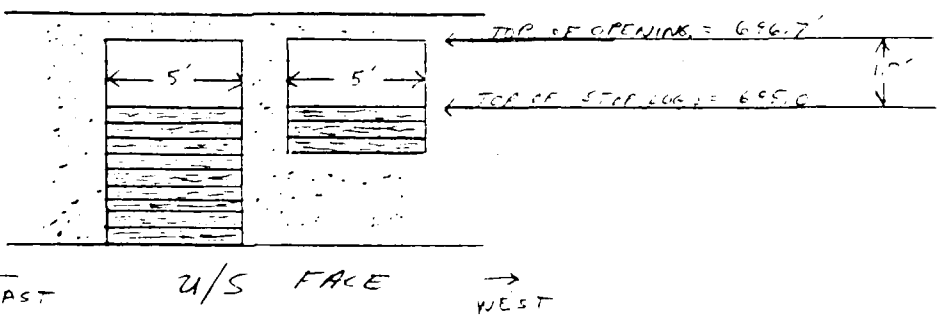
CALCULATE $Q_{b_1} = \frac{8}{27} w_b \sqrt{32.2}\, y_o^{3/2}$

$$Q_{b_1} = \frac{8}{27}(100)\sqrt{32.2}\,(5)^{3/2}$$

$$\boxed{Q_{b_1} = 1880 \text{ CFS}}$$

BECAUSE OF THE SLOPE OF THE TERRAIN D/S OF THIS BREACHED SECTION MOST OF THE WATER CONSTITUTING Q_{b_1} WOULD FIRST FLOW INTO THE STONE WALLED CHANNEL LOCATED DIRECTLY D/S OF THE TWO STOP LOG BAYS. THE TOTAL BREACH DISCHARGE, Q_{BT}, THEREFORE USED TO CALCULATE THE HAZARD D/S CAUSED BY THE BREACH SHOULD INCLUDE FLOW FROM THE STOP LOG BAYS AS WELL AS Q_{b_1}.

DIAGRAM OF STOP LOG BAYS



CONDITION I : (CONTINUED)

CALCULATION OF FLOW THROUGH THE STOP LOG BAYS, Q_{SL}, WITH THE WSEL @ TOP OF DAM = 696.7'.

USE WEIR EQUATION $Q = CLH^{3/2}$

★ WHERE $C = 3.3$

$L = 2 \times 5' = 10'$

$H = 1.7'$

$Q_{SL} = 3.3 \times 10 \times (1.7)^{3/2} = 73$ CFS @ WSEL = 696.7' (TOP OF DAM)

THEREFORE, THE TOTAL BREACH DISCHARGE IS EQUAL TO

$$Q_{BT_1} = Q_{b_1} + Q_{SL}$$

$$Q_{BT_1} = 1880 + 73$$

$$\boxed{Q_{BT_1} = 1953 \text{ CFS}}$$

THE ANTECEDENT DISCHARGE OR THE FLOW PASSING OVER THE DAM BEFORE THE BREACH, IS, IN THIS CASE, EQUAL TO THE FLOW THROUGH THE STOP LOG BAYS, Q_{SL}, AT A WSEL = 696.7'.

$$\boxed{Q_{ANTECEDENT} = Q_{SL} = 73 \text{ CFS.}}$$

★ UNLESS OTHERWISE NOTED, ALL COEFFICIENTS USED IN THE WEIR AS WELL AS THE ORIFICE EQUATION WERE TAKEN FROM THE KING AND BRATER HANDBOOK OF HYDRAULICS, SIXTH EDITION.

CONDITION I

CROSS SECTION # I – MIRROR LAKE ROAD LOCATED ~ 100' D/S OF DAM WITH A 36" Ø CORRUGATED METAL PIPE TRANSVERSING THE ROAD - SEE Pg D-8 FOR DETAILS.

DETERMINE THE MAXIMUM FLOW THE 36" Ø PIPE CAN ACCOMODATE BEFORE THE ROAD IS OVERTOPPED:

INV OF PIPE = 682.5' NGVD

TOP OF ROAD = 690.0' "

Δ ELEV = 690 - 682.5 = 7.5'

USE ORIFICE EQUATION $Q = CA\sqrt{2gH}$

$$Q = 0.8\,\pi\,(1.5)^2\sqrt{2 \times 32.2 \times \left(7.5 - \frac{3.0}{2}\right)} = 111 \text{ cfs}$$

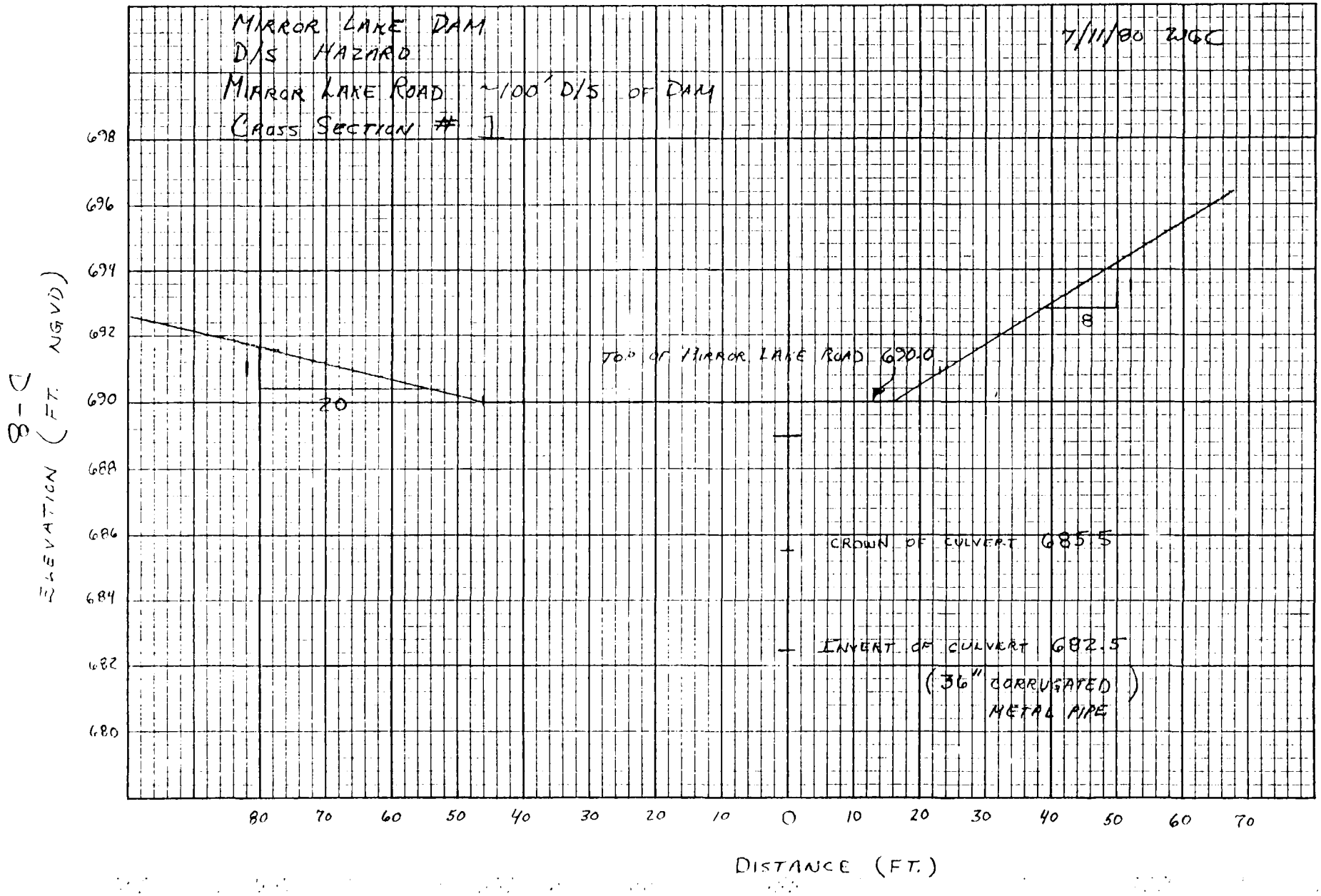
SINCE 111 CFS IS LESS THAN Q_{BT_1} = 1953 CFS, THE ROAD WILL BE OVERTOPPED. TO DETERMINE BY HOW MUCH THE ROAD WILL BE FLOODED, DEVELOPE A RATING CURVE FOR THIS CROSS SECTION. USE THE ORIFICE EQUATION TO RATE FLOW FROM A STAGE OF 3 FT TO THE TOP OF THE ROAD (7.5 FT). ABOVE 7.5 FT USE THE ORIFICE EQUATION FOR FLOW THROUGH THE PIPE AND THE WEIR EQUATION FOR FLOW OVER THE ROAD.

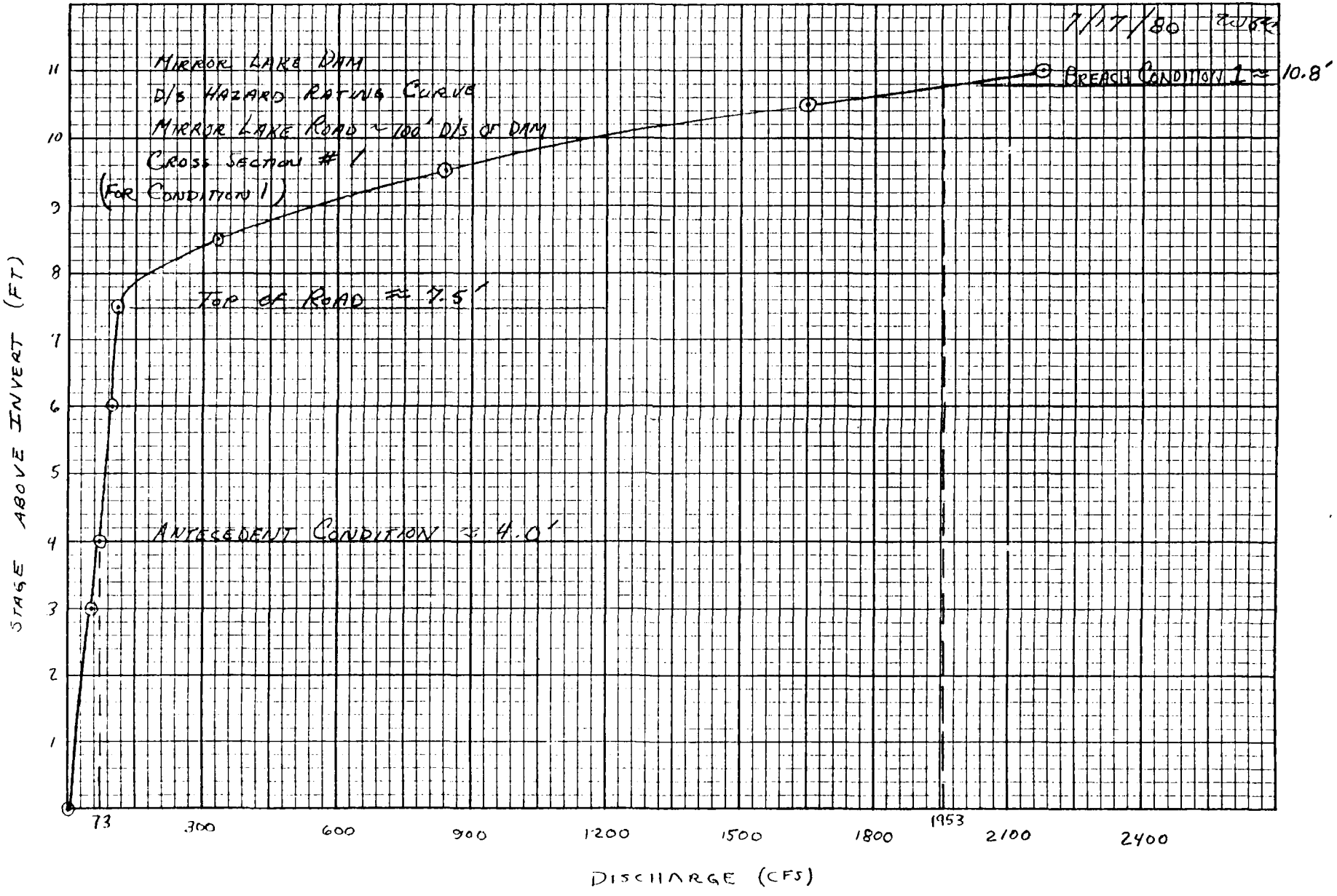
SQUARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
U. S. SCALE

CONDITION 1 (CONTINUED)

RATING CURVE DATA FOR CROSS SECTION #1

ELEVATION (FT NGVD)	STAGE ABOVE INVERT (FT)		DISCHARGE (CFS)
682.5	0		0
685.5	3	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(1.5)}$ =	56
686.5	4	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(2.5)}$ =	72
688.5	6	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(4.5)}$ =	96
690.0 (TOR)	7.5	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(6.0)}$ =	111
691.0	8.5	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(7.0)}$ $+(2.8)(62)(1)^{3/2} + (2.8)(\frac{1}{2})(8)(1)^{3/2}$ $+(2.8)(\frac{1}{2})(20)(1)^{3/2}$ =	333
692.0	9.5	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(8.0)}$ $+(2.8)(62)(2)^{3/2} + (2.8)(\frac{1}{2})(16)(2)^{3/2}$ $+(2.8)(40)(\frac{1}{2})(2)^{3/2}$ =	841
693.0	10.5	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(9.0)}$ $+(2.8)(62)(3)^{3/2} + (2.8)(\frac{1}{2})(24)(3)^{3/2}$ $+(2.8)(60)(\frac{1}{2})(3)^{3/2}$ =	1649
693.5	11.0	$Q = 0.8\pi(1.5)^2\sqrt{(64.4)(9.5)}$ $+(2.8)(62)(3.5)^{3/2} + (2.8)(\frac{1}{2})(28)(3.5)$ $+(2.8)(70)(\frac{1}{2})(3.5)^{3/2}$ =	2175




MIRROR LAKE DAM
D/S HAZARD RATING CURVE
MIRROR LAKE ROAD ~ 100' D/S OF DAM
CROSS SECTION # 1
(FOR CONDITION 1)
7/17/80
TOP OF ROAD ≈ 7.5'
ANTECEDENT CONDITION ≈ 4.0'
BREACH CONDITION 1 ≈ 10.8'
STAGE ABOVE INVERT (FT)
DISCHARGE (CFS)
0
1
2
3
4
5
6
7
8
9
10
11
73
300
600
900
1200
1500
1800
1953
2100
2400

G-9

Anderson-Nichols & Company, Inc.

Subject BREACH ANALYSIS
MIRROR LAKE DAM

Sheet No. 9 of 15
Date 7/17/80
Computed WGC
Checked ---

JOB NO. Job. No. 3273-25

SQUARES 1/4 IN. SCALE

CONDITION 1

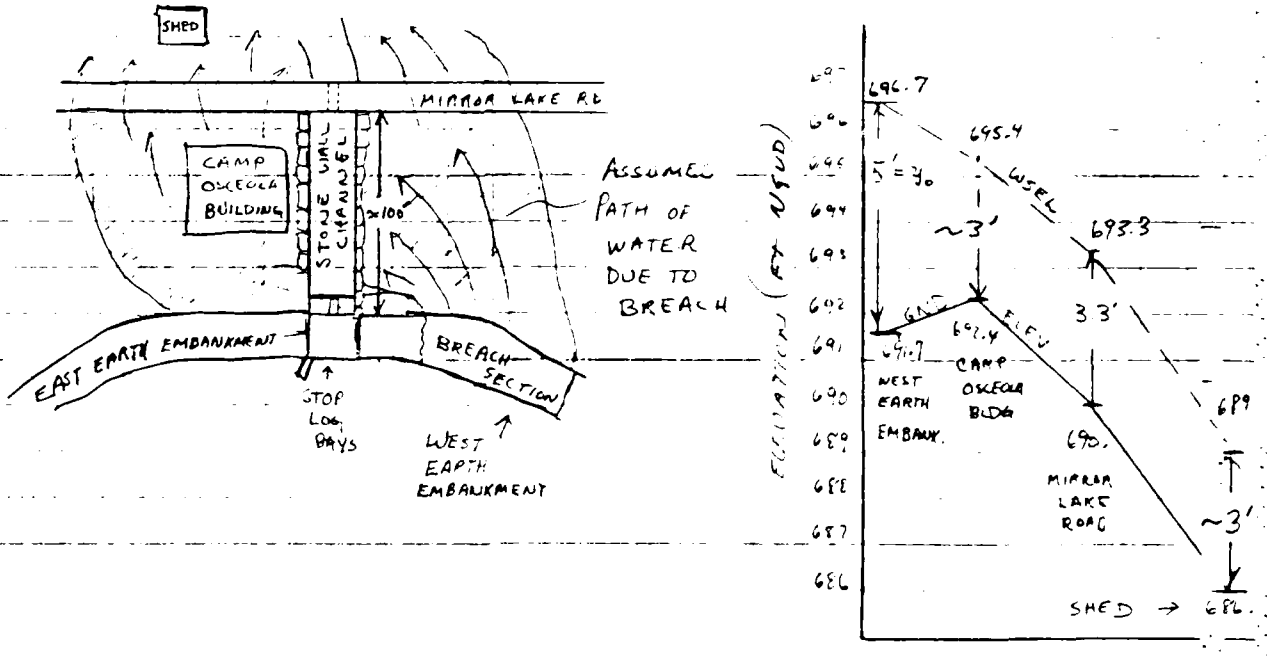
AT CROSS SECTION 1, A BREACH OF THE WEST EARTH EMBANKMENT WOULD CAUSE A RISE IN THE WSEL ABOVE THE NATURAL TAILWATER OF ABOUT

10.8 − 4.0 = 6.8 FT. (SEE RATING CURVE PG. D-9)

MIRROR LAKE ROAD WOULD BE OVERTOPPED BY A DEPTH EQUAL

10.8 − 7.5 = 3.3 FT.

IN ADDITION TO THE ROAD BEING FLOODED IT IS ALSO VERY LIKELY THAT THE CAMP OSCEOLA BUILDING LOCATED U/S OF THE ROAD AND THE UNINHABITED SHED LOCATED D/S OF THE ROAD WOULD ALSO BE INUNDATED BY ABOUT 3 FEET. THIS NUMBER WAS ARRIVED AT AFTER EXAMINATION OF THE RELATIVE POSITION AND ELEVATION OF THESE BUILDINGS WITH RESPECT TO THE BREACH SECTION AND MIRROR LAKE ROAD (CROSS SECTION # 1).



SQUARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
1/ IN. SCALE

CONDITION 2: BREACH OF EAST EARTH EMBANKMENT

BREACH WIDTH, (W_B) WAS ASSUMED TO EXTEND 78 FT. EAST FROM THE EAST END OF THE CONCRETE CORE WALL.

$$W_B = 78 \text{ FT}$$

AS IN "CONDITION 1", 'y_o' WAS MEASURED FROM THE TOP OF DAM, ELEV. = 696.7' NGVD, TO THE D/S TOE ELEVATION. HOWEVER, THE D/S TOE ELEVATIONS VARY THROUGHOUT THE ASSUMED BREACH SECTION. A WEIGHTED y_o WAS THEREFORE CALCULATED.

CALCULATION OF "WEIGHTED y_o"

$$\left[\left(\frac{(696.7-695.3)+(696.7-694.6)}{2}\right)\times 25' + \left(\frac{(696.7-694.6)+(696.7-693.2)}{2}\right)\times 25'\right.$$
$$+\left(\frac{(696.7-694.1)+(696.7-693.2)}{2}\right)\times 10' + \left(\frac{(696.7-694.1)+(696.7-693.4)}{2}\right)\times 15'$$
$$\left.+\left(\frac{(696.7-693.4)+(696.7-692.8)}{2}\right)\times 3'\right] \div 78' = 2.6' = y_o$$

CALCULATE $Q_{b_2} = \frac{8}{27} w_b \sqrt{32.2}\, y_o^{3/2}$

$$Q_{b_2} = \frac{8}{27}(78)\sqrt{32.2}\,(2.6)^{3/2}$$

$$Q_{b_2} = 550 \text{ CFS.}$$

CONDITION 2 (CONTINUED)

VISUAL OBSERVATION OF THE AREA D/S OF THE EAST EARTH EMBANKMENT SUGGESTED THAT MOST OF THE WATER FLOWING THROUGH THE ASSUMED BREACH SECTION WOULD NOT COMBINE WITH FLOW FROM THE TWO STOP LOG BAYS (Q_{SL} = 73 CFS ⇒ SEE PG. D-15) UNTIL IT REACHES A POINT D/S OF MIRROR LAKE ROAD. HOWEVER SINCE WE WERE PRIMARILY INTERESTED IN ANALYZING THE EFFECTS OF THE BREACH ON MIRROR LAKE ROAD AND AREAS U/S, IT WAS NOT CONSIDERED NECESSARY TO ADD THE FLOW FROM THE STOP LOG BAYS, Q_{SL}, TO THE FLOW CAUSED BY THE BREACH, Q_{b_2}, TO OBTAIN THE TOTAL BREACH DISCHARGE Q_{BT_2}. THEREFORE FOR CONDITION 2

$$Q_{BT_2} = Q_{b_2}$$

$$\boxed{Q_{BT_2} = 550 \text{ CFS}}$$

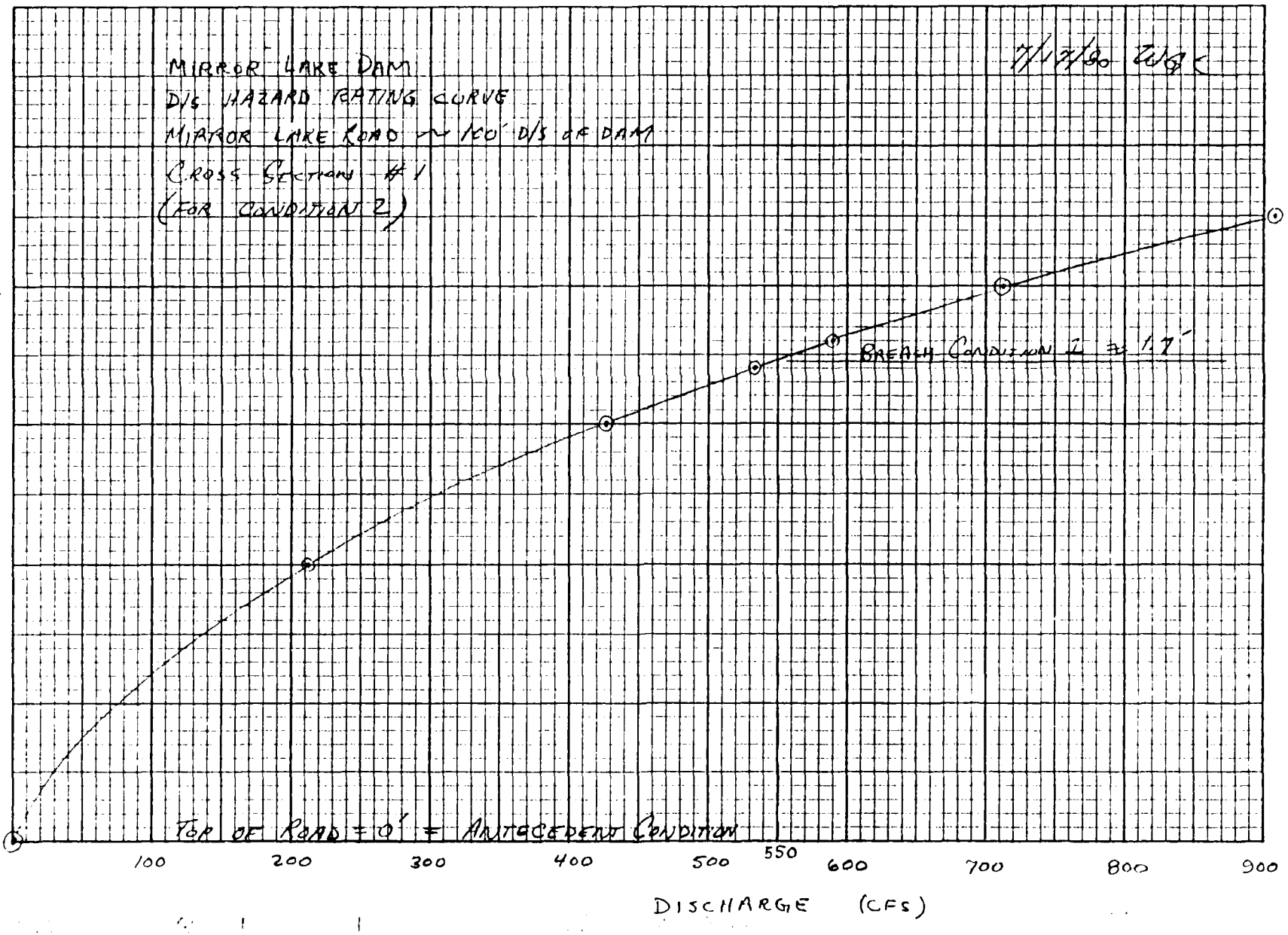
CONDITION 2 :

CROSS SECTION #1 – MIRROR LAKE ROAD LOCATED ~100' S/S OF DAM WITH A 36" Ø CORRUGATED METAL PIPE TRANSVERSING THE ROAD - SEE Pg D-8 FOR DETAILS.

WE ARE ASSUMING MOST OF TOTAL BREACH DISCHARGE Q_{BT_2} = 550 CFS WILL PASS OVER THE ROAD BEFORE COMBINING WITH THE FLOW FROM THE STOP LOG BAYS (Q_{SL} = 78 CFS) WHICH FLOWS UNDER MIRROR LAKE ROAD THROUGH THE 36" Ø CORRUGATED METAL PIPE. TO DETERMINE THE DEPTH OF WATER OVERTOPPING THE ROAD, WE THEREFORE DEVELOPED A STAGE DISCHARGE CURVE UTILIZING THE WEIR EQUATION ONLY.

RATING CURVE DATA FOR CROSS SECTION #1

ELEVATION (F. MSL)	STAGE ABOVE ROAD (FT.)	DISCHARGE (CFS)
690.0	0	0
691.0	1	$Q = (2.8)(62)(1)^{3/2} + 2.8(8)(\frac{1}{2})(1)^{3/2} + (2.8)(20)(\frac{1}{2})(1)^{3/2}$ = 213
691.5	1.5	$Q = (2.8)(62)(1.5)^{3/2} + (2.8)(12)(\frac{1}{2})(1.5)^{3/2} + 2.8(30)(\frac{1}{2})(1.5)^{3/2}$ = 427
691.7	1.7	$Q = 2.8(62)(1.7)^{3/2} + 2.8(13.6)(\frac{1}{2})(1.7)^{3/2} + 2.8(34)(\frac{1}{2})(1.7)^{3/2}$ = 532
691.8	1.8	$Q = 2.8(62)(1.8)^{3/2} + 2.8(14.4)(\frac{1}{2})(1.8)^{3/2} + 2.8(36)(\frac{1}{2})(1.8)^{3/2}$ = 596
692.0	2.0	$Q = (2.8)(62)(2.0)^{3/2} + 2.8(16)(\frac{1}{2})(2)^{3/2} + 2.8(40)(\frac{1}{2})(2)^{3/2}$ = 713
692.5	2.5	$Q = (2.8)(62)(2.5)^{3/2} + 2.8(20)(\frac{1}{2})(2.5)^{3/2} + 2.8(50)(\frac{1}{2})(2.5)^{3/2}$ = 908



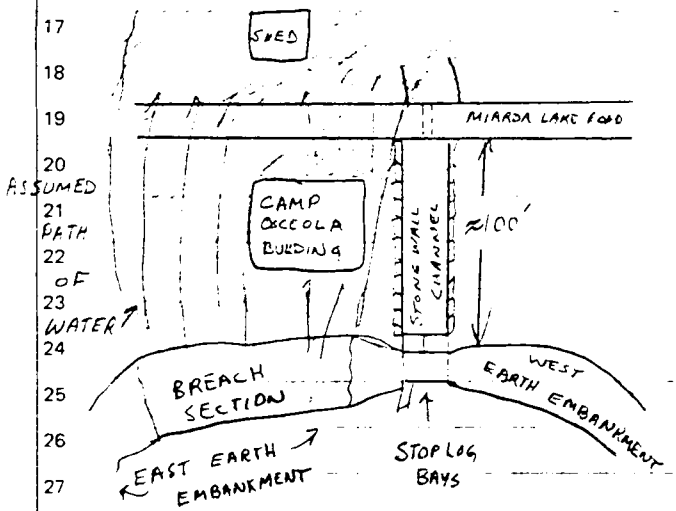
M-4

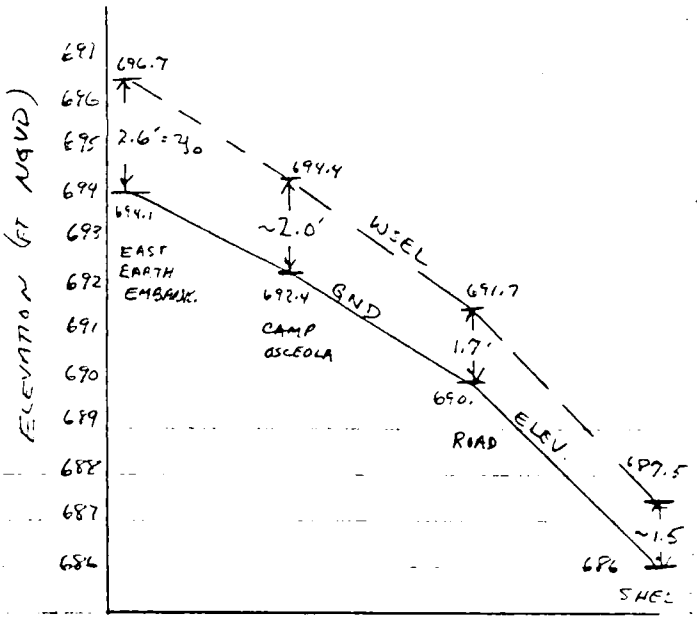
JARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

CONDITION 2

A BREACH OF THE EAST EARTH EMBANKMENT WOULD CAUSE MIRROR LAKE ROAD TO BE OVERTOPPED BY ABOUT 1.7 FT.

IN ADDITION, THE CAMP OSCEOLA BUILDING AND THE UNINHABITED SHED LOCATED DIRECTLY IN THE PATH OF THE BREACH DISCHARGE WERE ASSUMED TO BE INUNDATED BY 2.0 and 1.5 FT RESPECTIVELY. THESE FIGURES WERE ARRIVED AT AFTER EXAMINATION OF THE RELATIVE POSITIONS AND ELEVATIONS OF THESE TWO STRUCTURES WITH RESPECT TO THE BREACH SECTION AND MIRROR LAKE ROAD (CROSS SECTION #1) SEE THE DIAGRAMS BELOW.





SQUARES 1/4 IN. SCALE

HAZARD CONCLUSIONS:

TWO BREACH ANALYSIS WERE PERFORMED; ONE FOR THE WEST AND ONE FOR THE EAST EARTH EMBANKMENTS WHICH ARE REFERRED TO AS CONDITION 1 AND CONDITION 2 RESPECTIVELY.

RESULTS INDICATE THAT SHOULD THE WEST EARTH EMBANKMENT FAIL THERE WOULD BE AN INCREASE IN WSEL ABOVE THE NATURAL TAILWATER WSEL OF ABOUT 6.8 FEET. THIS WOULD RESULT IN MIAROR LAKE ROAD BEING OVERTOPPED BY 3.3 FT WHICH COULD CAUSE APPRECIABLE DAMAGE TO THE ROAD. FURTHERMORE THE CAMP OSCEOLA BUILDING LOCATED U/S OF MIRROR LAKE ROAD AND THE UNINHABITED SHED LOCATED D/S OF THE ROAD COULD EACH BE INUNDATED BY APPROXIMATELY 3 FEET OF WATER. CONSEQUENTLY THERE IS THE POTENTIAL FOR THE LOSS OF 1-2 LIVES AND CONSIDERABLE PROPERTY DAMAGE.

THE BREACH ANALYSIS FOR THE EAST EARTH EMBANKMENT INDICATED THAT MIRROR LAKE ROAD WOULD BE OVERTOPPED BY 1.7 FEET OF WATER WHICH COULD HINDER ITS USE AS AN ACCESS ROAD. IN ADDITION, THE CAMP OSCEOLA BUILDING AND THE UNINHABITED SHED COULD BE INUNDATED BY 2 AND 1.5 FEET OF WATER RESPECTIVELY WITH THE POSSIBLE LOSS OF 1-2 LIVES AND SOME PROPERTY DAMAGE.

BOTH ANALYSIS THEREFORE SUGGEST THE POTENTIAL FOR A LOSS OF 1-2 LIVES AND APPRECIABLE PROPERTY DAMAGE. FOR THIS REASON MIRROR LAKE DAM WAS CONSIDERED A

SIGNIFICANT HAZARD!

SQUARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 3
1 IN. SCALE

MIRROR LAKE DAM TEST FLOOD ANALYSIS

DRAINAGE AREA (D.A.) : 0.34 Mi^2. — (SHEETS IN THE NHWRB FILES REPORT A D.A. OF 0.43 $M.^2$. AN ATTEMPT WAS MADE TO VERIFY THIS VALUE BY PLANIMETERING THE D.A. OFF OF A 1:62,500 SCALE USGS QUAD (PLYMOUTH, N.H.). RESULTS INDICATED A D.A. NO LARGER THAN ABOUT 0.34 Mi^2. THIS VALUE OF 0.34 $M.^2$ WAS CONSIDERED AN ACCURATE ESTIMATE OF THE D.A. AND WAS USED IN PLACE OF THE NHWRB VALUE, 0.43 $M.^2$, WHICH WE WERE NOT ABLE TO JUSTIFY.)

SIZE CLASSIFICATION : SMALL
MAXIMUM STORAGE CAPACITY = 750 Ac-Ft
HYDRAULIC HEIGHT (696.7-685.2) = 11.5 Ft

HAZARD CLASSIFICATION : SIGNIFICANT

TEST FLOOD RANGE : 100 YR TO ½ PMF

CHOSEN TEST FLOOD : ½ PMF BECAUSE OF THE POTENTIAL FOR THE LOSS OF 0 TO 2 LIVES.

SQUARES 1/4 IN. SCALE

STEP #1 : DETERMINE PEAK INFLOW (Q_{P_1})

- THE SLOPE OF THE WATERSHED WAS CALCULATED TO BE EQUAL TO 616 FT/MI.

  [Δ ELEVATION = 1280 − 695 = 585 FT
  LENGTH OF BASIN = 0.95 MI]

- TO DETERMINE THE PROBABLE MAXIMUM FLOOD (PMF) IN CSM FOR THIS AREA, THE "MAXIMUM PROBABLE FLOOD PEAK FLOW RATES" GRAPH PROVIDED BY THE COE WAS CONSULTED. THE STEEP SLOPE OF THIS WATERSHED (616 FT/MI) QUALIFIES IT AS MOUNTAINOUS TERRAIN (SLOPES > 20 FT/MI). THE MAXIMUM ALLOWABLE PMF OF 2550 CSM WAS USED IN THE FOLLOWING CALCULATIONS SINCE THE CSM VALUE CORRESPONDING TO A D.A OF 0.34 MI^2 IN A MOUNTAINOUS TERRAIN WOULD EXCEED THE 255 CSM LIMIT.

- $2550 \frac{CFS}{MI^2} \times \underset{\uparrow \text{D.A.}}{0.34\ MI^2} = 867\ CFS = PMF$

- PEAK INFLOW = ½ PMF = $\frac{867}{2}$ = 434 CFS

  PEAK INFLOW = Q_{P_1} = 434 CFS

- CHECK : ACCORDING TO COE GUIDANCE, THE 100 YEAR FLOOD IS ROUGHLY EQUIVELENT TO ¼ THE PMF

  ∴ 100 YEAR ≅ $\frac{867}{4}$ = 217 CFS

  THIS VALUE OF 217 CFS COMPARES VERY WELL WITH THE VALUE OF 210 CFS FOR THE 100 YR FLOOD FOUND IN THE NHWRB FILES.

STEP # 2a — DETERMINE SURCHARGE HEIGHT TO PASS Q_p = 434 CFS

- TO DO THIS IT WAS NECESSARY TO DEVELOPE A RATING CURVE FOR MIRROR LAKE DAM. THE CURVE TAKES INTO ACCOUNT FLOW THROUGH THE TWO STOP LOG BAYS, OVER THE EAST AND WEST EARTH EMBANKMENTS AND THE 14 FT CONCRETE PAD ABOVE THE STOP LOG BAYS AS WELL AS A NATURAL SADDLE LOCATED NW OF THE DAM. THE FOLLOWING IS A LIST OF THESE OUTFLOW AREAS WITH THEIR CREST ELEVATIONS, LOCATION AND EQUATIONS USED TO RATE THEIR FLOW.

STOP LOG BAYS

a) WITH STOP LOGS IN PLACE:

TOP OF STOP LOGS = 695.0' NGVD

★ WEIR EQN TO ELEV 696.7' = $Q = 3.3 L H^{3/2}$

⊕ ORIFICE EQNS FOR ELEV > 696.7' = $Q = C A \sqrt{2gH}$

☒ b) WITHOUT STOP LOGS:

BOTTOM OF LEFT BAY = 688.9' NGVD; BOTTOM OF RT BAY = 692.0' NGVD

★ WEIR EQNS TO ELEV 696.7': LT BAY = $Q = 2.7 L H^{3/2}$; RT BAY = $Q = 2.8 L H^{3/2}$

⊕ ORIFICE EQN FOR ELEV > 696.7' (BOTH BAYS) = $Q = C A \sqrt{2gH}$

NATURAL SADDLE

400'± NW OF DAM

CREST ELEV. = 696.5' NGVD

★ WEIR EQN = $Q = 2.7 L H^{3/2}$

EAST AND WEST EARTH EMBANKMENTS

LOW POINT = 696.7' NGVD

★ WEIR EQN = $Q = 2.7 L H^{3/2}$

CONCRETE PAD OVER STOP LOG BAYS

ELEVATION = 697.2' NGVD

★ WEIR EQN = $Q = 2.8 L H^{3/2}$

★ 'C' VALUE TAKEN FROM THE 'KING AND BRATER HANDBOOK OF HYDRAULICS', SIXTH EDITION

⊕ 'C' VALUE ADJUSTED TILL VALUE OF Q AT ELEV = 697.2' MATCHED REASONABLY WELL WITH WEIR EQN Q AT ELEV = 696.7

☒ [illegible]

Anderson-Nichols & Company, Inc.

JOB NO. 3273-25

Subject TEST FLOOD ANALYSIS
MIRROR LAKE DAM

Sheet No. 4 of 15
Date 7/15/80
Computed WGC
Checked

SQUARES 1/4 IN. SCALE

CALCULATIONS FOR THE MIRROR LAKE RATING CURVE ARE SHOWN BELOW:

WITH TOP OF STOP LOGS IN BOTH BAYS AT ELEVATION = 69

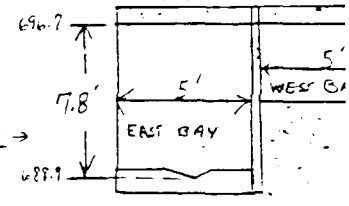
AREA = $2 \times 5 \times 1.7 = 17\ FT^2 = A$

$C = 3.3$ FOR WEIR EQN $Q = CLH^{3/2}$

$C = 0.5$ FOR ORIFICE EQN $Q = CA\sqrt{2gH}$

$L = 2 \times 5' = 10\ FT$

ELEV (NGVD)	H_{WEIR} (FT)	H_{ORIF} (FT)	Q (CFS
695.0	0	—	$Q = 3.3(10)(0)^{3/2} = 0$
696.0	1.0	—	$Q = (3.3)(10)(1)^{3/2} = 33$
696.5	1.5	—	$Q = (3.3)(10)(1.5)^{3/2} = 50$
696.7	1.7	—	$Q = (3.3)(10)(1.7)^{3/2} = 73$
697.2	—	1.35	$Q = (0.5)(17)(\sqrt{64.4})(1.35) =$
698.0	—	2.15	$Q = (0.5)(17)(\sqrt{64.4})(2.15) =$
699.0	—	3.15	$Q = (0.5)(17)(\sqrt{64.4})(3.15) =$



WITHOUT STOP LOGS IN EITHER BAY →

EAST BAY : AREA = $7.8' \times 5' = 39\ FT^2$;

$C = 2.7$ WEIR $C = 0.5$ ORIF

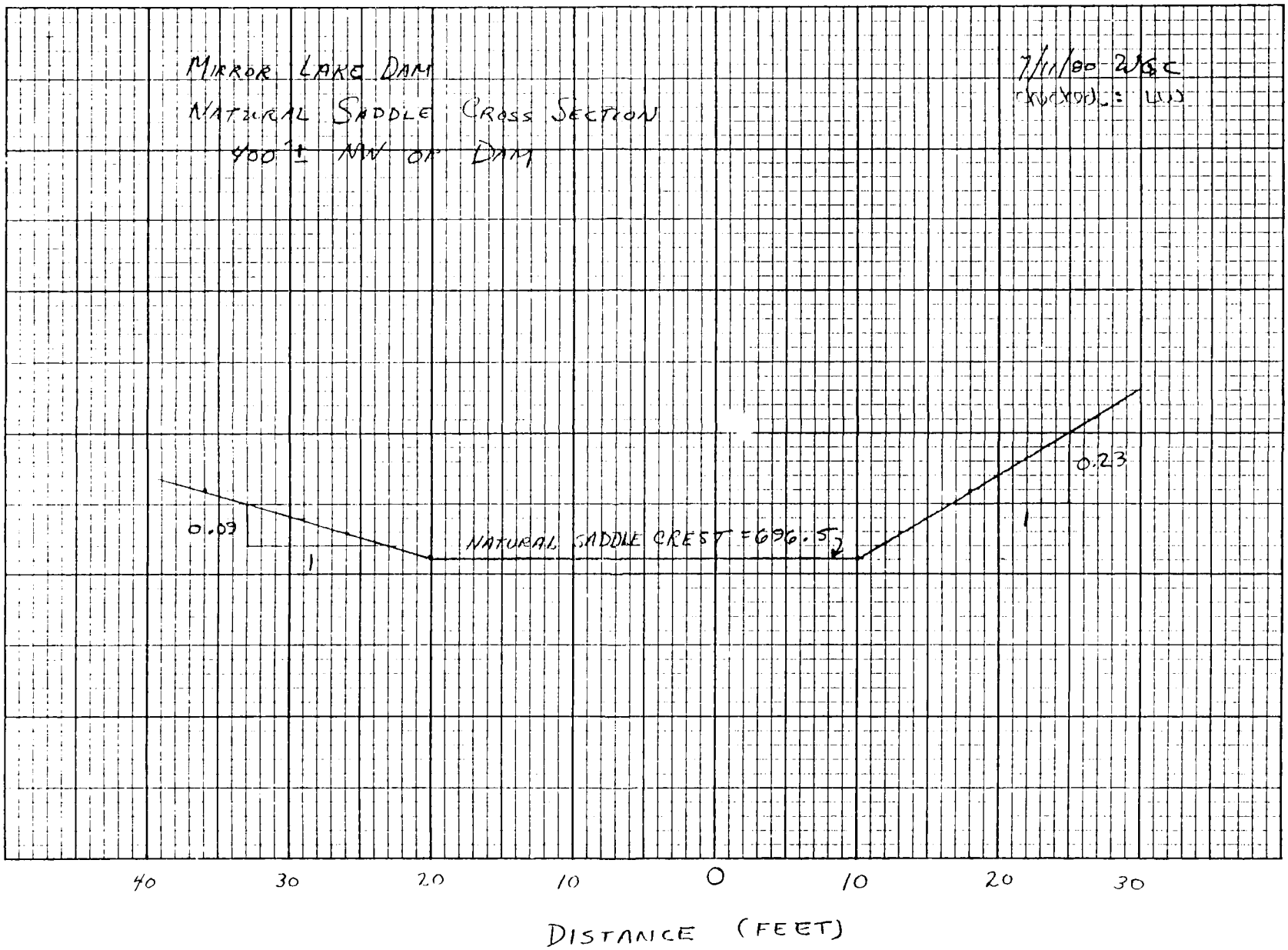
WEST BAY : AREA = $3.8' \times 5' = 19\ FT^2$

$C = 2.8$ WEIR $C = 0.5$ ORIF

ELEV. NGVD.	EAST BAY H_{WEIR}	EAST BAY H_{ORIF}	EAST BAY Q_L (CFS)	WEST BAY H_{WEIR}	WEST BAY H_{ORIF}	Q_R (CFS)	Q_T (CFS) $(Q_L + Q_R)$
695	6.1'	-	203	2.1'	-	43	246
696	7.1'	-	255	3.1'	-	76	331
696.5	7.6'	-	283	3.6'	-	96	379
696.7	7.8'	-	294	3.8'	-	104	398
697.2	-	4.4'	328	—	2.4'	110	438
698.0	-	5.2'	357	—	3.2'	136	493
699.0	-	6.2'	390	—	4.2'	156	546

NATURAL SADDLE : $C = 2.7$ FOR WEIR EQUATION (SEE Pg

ELEV. (NGVD)	H_{WEIR} (FT)	
696.5	0	
696.7	.2	$Q = (2.7)(30)(.2)^{3/2} + (2.7)\left(\frac{1}{2}\times.2\times\frac{1}{2}\right)(.2)^{3/2}$
		$+(2.7)\left(\frac{1}{2}\times.2\times\frac{1}{2}\right)(.2)^{3/2} =$
697.2	.7	$Q = (2.7)(30)(.7)^{3/2} + (2.7)\left(\frac{1}{2}\times.7\times\frac{1}{2}\right)(.7)^{3/2}$
		$+(2.7)\left(\frac{1}{2}\times.7\times\frac{1}{2}\right)(.7)^{3/2} =$



SQUARES /4 IN. SCALE

CALCULATIONS FOR MIRROR LAKE RATING CURVE (CONTINUED)

NATURAL SADDLE (CONTINUED)

ELEV. (NGVD)	H_{WEIR} (FT)	Q (CFS)
698.0	1.5	$Q = (2.7)(30)(1.5)^{3/2} + (2.7)\left(\frac{1}{.09} \times 1.5 \times \frac{1}{2}\right)(1.5)^{3/2} + (2.7)\left(\frac{1}{.23} \times 1.5 \times \frac{1}{2}\right)(1.5)^{3/2} = 206$
699.0	2.5	$Q = (2.7)(30)(2.5)^{3/2} + (2.7)\left(\frac{1}{.09} \times 2.5 \times \frac{1}{2}\right)(2.5)^{3/2} + (2.7)\left(\frac{1}{.23} \times 2.5 \times \frac{1}{2}\right)(2.5)^{3/2} = 526$

EAST AND WEST EARTH EMBANKMENTS

C = 2.7 FOR WEIR EQUATION $Q = CLH^{3/2}$

ELEV (NGVD)	H_{WEIR} (FT)	Q (CFS)
696.7	0	0
697.2	VARIES	$Q = (2.7)(7)(.2)^{3/2} + (2.7)(16)(.2)^{3/2} + (2.7)(9)(.1)^{3/2} + (2.7)(6)(.05)^{3/2} = 7$
698.0	VARIES	$Q = (2.7)(25)(.4)^{3/2} + (2.7)(4)(.4)^{3/2} + (2.7)(12)(.3)^{3/2} + (2.7)(25)(.7)^{3/2} + (2.7)(35)(.6)^{3/2} + (2.7)(15)(.7)^{3/2} + (2.7)(11)(1.1)^{3/2} + (2.7)(7)(1.2)^{3/2} + (2.7)(18)(.9)^{3/2} + (2.7)(25)(.6)^{3/2} + (2.7)(25)(.7)^{3/2} + (2.7)(25)(.5)^{3/2} + (2.7)(25)(.7)^{3/2} + (2.7)(25)(.6)^{3/2} + (2.7)(15)(.2)^{3/2} = 426$

SQUARES 1/4 I. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

CALCULATIONS FOR MIRROR LAKE RATING CURVE (CONTINUED)

EAST AND WEST EARTH EMBANKMENTS (CONTINUED)

ELEV. (NGVD)	H WEIR (FT)	Q (CFS)
699.0	VARIES	$Q = (2.7)(15)(.6)^{3/2} + (2.7)(25)(1.4)^{3/2} + (2.7)(5)(1.4)^{3/2} + (2.7)(20)(1.1)^{3/2} + (2.7)(25)(1.6)^{3/2} + (2.7)(35)(1.6)^{3/2} + (2.7)(15)(1.7)^{3/2} + (2.7)(11)(2.1)^{3/2} + (2.7)(7)(2.2)^{3/2} + (2.7)(18)(1.8)^{3/2} + (2.7)(25)(1.5)^{3/2} + (2.7)(25)(1.7)^{3/2} + (2.7)(25)(1.7)^{3/2} + (2.7)(25)(1.7)^{3/2} + (2.7)(40)(1.4)^{3/2} + (2.7)(8)(.5)^{3/2} = 1663$

CONCRETE PAD OVER THE TWO STOP LOG BAYS

$C = 2.8$ FOR WEIR EQN $Q = CLH^{3/2}$

ELEV. (NGVD)	H WEIR (FT)		Q (CFS)
697.2	0		0
698.0	.8	$Q = (2.8)(14)(.8)^{3/2}$	28
699.0	1.8	$Q = (2.8)(14)(1.8)^{3/2}$	95

POINTS USED TO PLOT MIRROR LAKE RATING CURVE

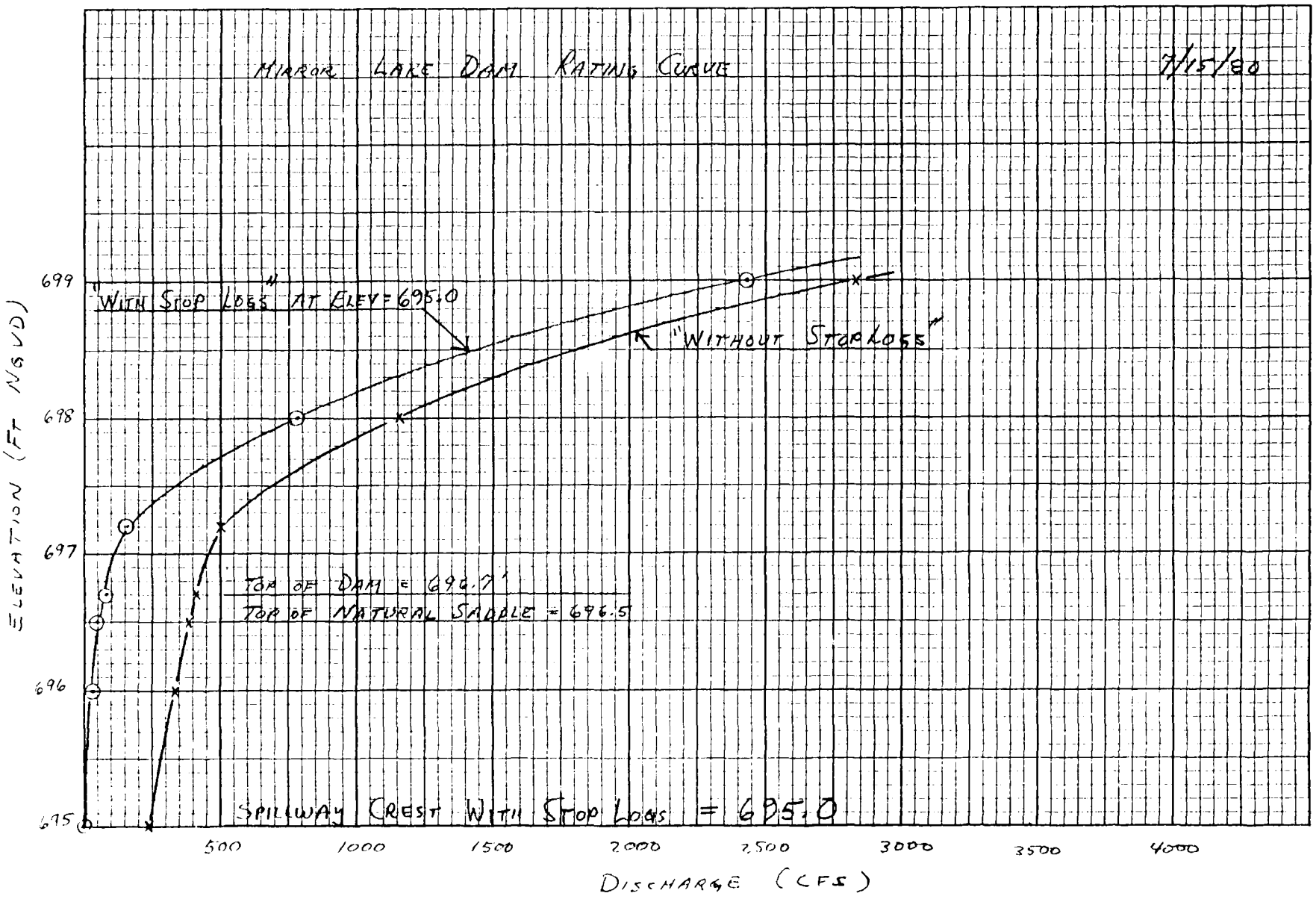
ELEV. (FT NGVD)	WITH STOP LOGS Q (CFS)	WITHOUT STOP LOGS Q (CFS)	NATURAL SADDLE Q (CFS)	EARTH EMBANKMENTS Q (CFS)	CONCRETE PAD Q (CFS)	WITH STOP LOGS Q (CFS) TOTAL	WITHOUT STOP LOGS Q (CFS) TOTAL
695.0	0	246				0	246
696.0	33	331				33	331
696.5	50	379	0			50	379
696.7	73	398	7	0		80	405
697.2	95	438	55	7	0	157	500
698.0	120	493	206	426	28	780	1153
699.0	145	546	526	1663	95	2429	2830
Late addition @ 697.5	88	464	102	89	6	285	661
@ 697.3	82	452	70	22	1	175	545

USING THE "WITH STOP LOGS" RATING CURVE (PG D-25), THE ELEVATION OF THE LAKE AT Q_{P_1} = 434 CFS MAY BE DETERMINED.

Q_{P_1} = 434 CFS ⇒ 697.7' NGVD = SURCHARGE HEIGHT TO PASS Q_{P_1}

STEP # 2b DETERMINE THE VOLUME OF SURCHARGE (STOR

TO DO THIS A STORAGE ELEVATION CURVE MUST BE CONSTRUCTED. THE FOLLOWING PAGES SHOW THE CALCULATIONS FOR THE STORAGE ELEVATION CURVE AND THE CURVE ITSELF.


MIRROR LAKE DAM RATING CURVE
7/15/80
"WITH STOP LOGS" AT ELEV = 695.0
"WITHOUT STOPLOGS"
TOP OF DAM = 696.7'
TOP OF NATURAL SADDLE = 696.5
SPILLWAY CREST WITH STOP LOGS = 695.0
ELEVATION (FT NGVD)
699
698
697
696
695
500
1000
1500
2000
2500
3000
3500
4000
DISCHARGE (CFS)

32-1

SQUARES 1/4 IN. SCALE

CALCULATIONS FOR "STORAGE VS ELEVATION" CURVE (AND SURFACE AREA VS. ELEV." CURVE)

ELEVATION = 695 FEET (NGVD) = NORMAL POOL ELEVATION (FROM DWG)

SURFACE AREA OF MIRROR LAKE = 37 ACRES

★ AVERAGE DEPTH = 18.3 FEET

STORAGE = 37 × 18.3 = 677 ACRE FEET

USING "FRUSTUM OF PYRAMID EQUATION" AND PLANIMETERED SURFACE AREAS, DEVELOPE POINTS FOR STORAGE ELEVATION CURVE

$$V = \frac{1}{3} h \left(b_1 + b_2 + \sqrt{b_1 b_2} \right)$$

b_1 = ENLARGED SURFACE AREA (ACRES)
b_2 = NORMAL POOL SURFACE AREA (ACRES)
h = ELEVATION ABOVE NORMAL POOL (FEET)

② ELEVATION = 700 FEET (NGVD)

SURFACE AREA = 55 ACRES

CHANGE IN ELEV = 5 FEET

$V = \frac{1}{3}(5)\left(37 + 55 + \sqrt{(37)\cdot(55)}\right) = 229$ ACRE-FEET

TOTAL STORAGE (@ 700') = 677 + 229 = 906 ACRE-FEET

③ ELEVATION = 720 FEET (NGVD)

SURFACE AREA = 78 ACRES

CHANGE IN ELEV = 20 FEET

$V = \frac{1}{3}(20)\left(55 + 78 + \sqrt{(55)\times(78)}\right) = 1323$ ACRE-FEET

TOTAL STORAGE = 906 + 1323 = 2229 ACRE-FEET

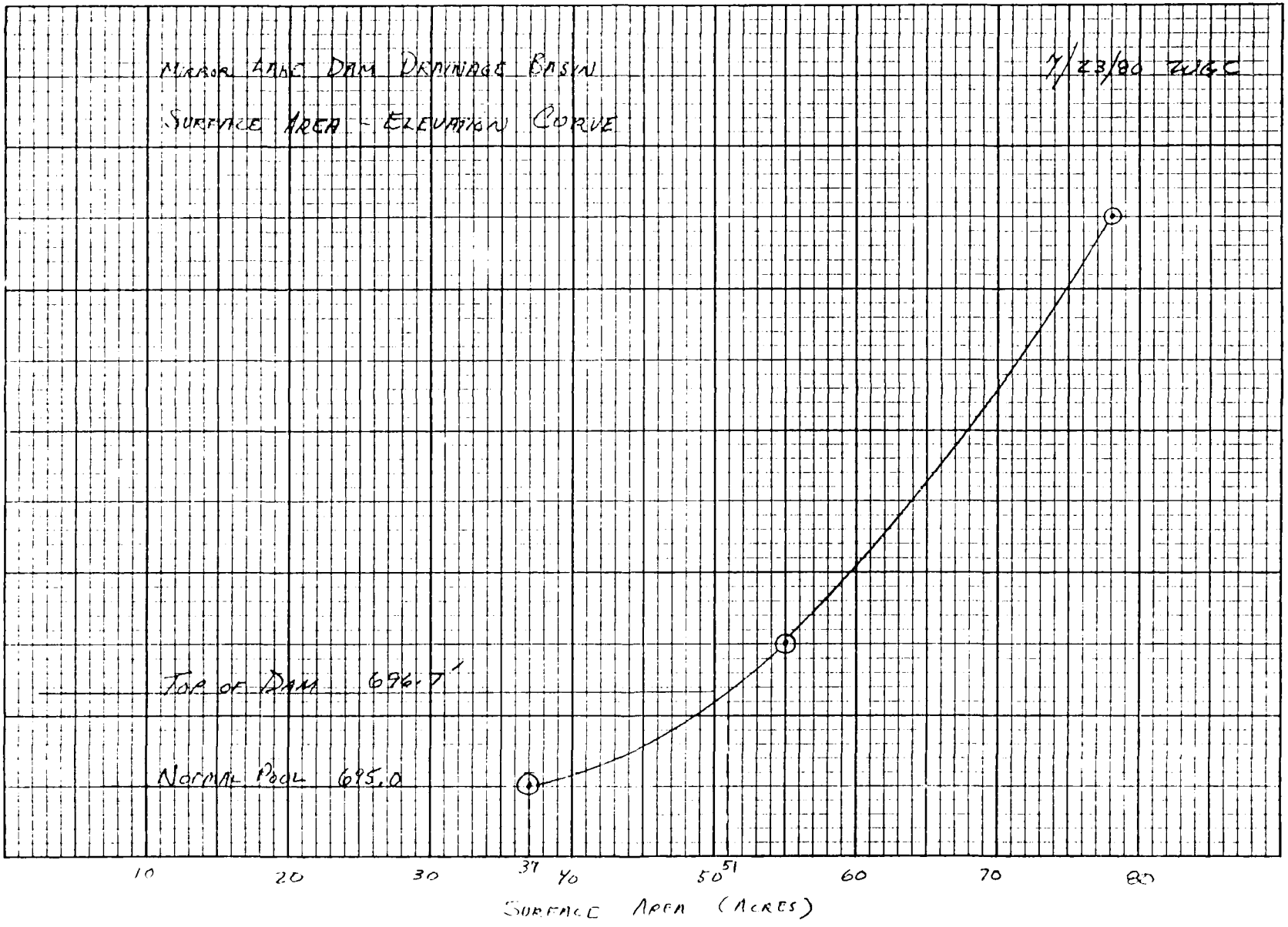
★ [illegible]

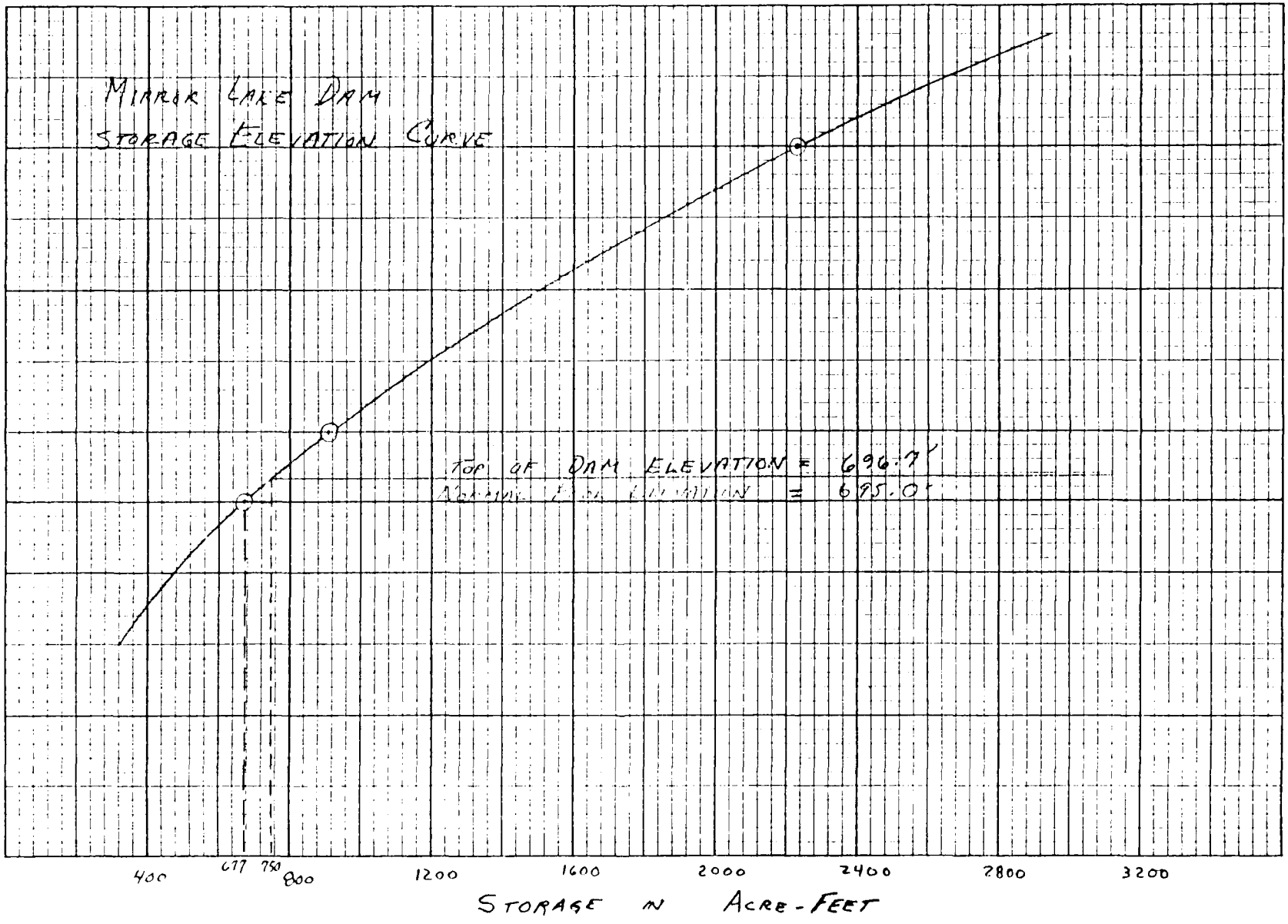
Morphometric measurements of Mirror Lake, New Hampshire (1968)

43° 56.5'N, 71° 41.5'E

Maximum Effective Length	617 m	Average Depth	5.57 m
Maximum Effective Width	358 m	Length of Shoreline	1840 m
Area	14.9 ha	Shore Development	1.3
Maximum Depth	10.9 m	Volume Development	1.5

Depth (m)	Area $m^2 \times 10^4$	(% of total)	Stratum (m)	Volume $m^3 \times 10^3$	(% of total)
0	14.9	100.0	0-1	143	17.2
1	13.7	91.7	1-2	130	15.7
2	12.4	83.4	2-3	118	14.2
3	11.3	76.0	3-4	108	13.0
4	10.3	69.0	4-5	98.0	11.8
5	9.3	62.5	5-6	87.4	10.5
6	8.2	55.0	6-7	70.7	8.5
7	6.0	39.9	7-8	43.6	5.3
8	2.9	19.6	8-9	21.6	2.6
9	1.5	10.1	9-10	8.9	1.1
10	0.4	2.9	10-10.9	1.2	011
			Total	830	100.0




MIRROR LAKE DAM
STORAGE ELEVATION CURVE
TOP OF DAM ELEVATION = 696.7'
NORMAL POOL ELEVATION = 695.0'
400
677
750
800
1200
1600
2000
2400
2800
3200
STORAGE IN ACRE-FEET

SQUARES 1/4 IN. SCALE

STEP #2b DETERMINING THE VOLUME OF SURCHARGE (STOR 1) (CONTINUED)

TEST FLOOD INFLOW ELEVATION = 697.7'
STORAGE AT 697.7' = 790 AC-FT
NORMAL STORAGE = 677 AC-FT
SURCHARGE STORAGE = 790 - 677 = 113 AC-FT

$$113 \text{ AC-FT} \times \left(\frac{1}{0.34 \text{ M.}^2}\right) \times \left(\frac{\text{M.}^2}{640 \text{ AC}}\right) = 0.52' = \underline{6.23''}$$

STOR 1 = 6.23"

STEP #2c DETERMINE Qp_2

$$Qp_2 = Qp_1 \times \left(1 - \frac{\text{STOR 1}}{19''}\right) \quad \text{IF TEST FLOOD = FULL PMF}$$

SINCE THE TEST FLOOD IN THIS ANALYSIS = $\frac{1}{2}$ PMF

$$Qp_2 = Qp_1 \times \left(1 - \frac{\text{STOR 1}}{(19/2)}\right)$$

$$\therefore \quad Qp_2 = 434 \times \left(1 - \frac{6.23}{9.5}\right)$$

Qp_2 = 149 CFS

STEP #3a DETERMINE SURCHARGE HEIGHT AND (STOR 2) TO PASS Qp_2

FROM THE MIRROR LAKE RATING CURVE ("WITH STOP LOGS" Pg 2-7)

AT Qp_2 = 149 CFS $\Rightarrow$ ELEV. = 697.2 = SURCHARGE HEIGHT

FROM THE STORAGE ELEV. CURVE (Pg D-29)

AT ELEV = 697.2 $\Rightarrow$ STORAGE = 790 AC-FT

STEP #3a DETERMINING SURCHARGE HEIGHT AND (STOR 2) TO PASS Qp_2 (WITHOUT)

SURCHARGE STORAGE = 775 − 677 = 98 AC-FT

$$98 \text{ AC-FT} \times \frac{1}{0.34 \text{ M.}^2} \times \frac{\text{M.}^2}{640 \text{ AC}} = 0.43' = \boxed{5.13'' = \text{STOR 2}}$$

STEP #3b DETERMINE AVERAGE SURCHARGE AND Qp_3

$$\frac{\text{STOR 1} + \text{STOR 2}}{2} = \frac{6.23 + 5.13}{2} = \boxed{5.68'' = \text{AVE STOR}}$$

$$Qp_3 = Qp_1\left(1 - \frac{\text{AVE STOR}}{9.5}\right) = 434\left(1 - \frac{5.68}{9.5}\right) = \boxed{175 \text{ CFS.} = Qp_3}$$

STEP #4 DETERMINE STOR 3 AND COMPARE WITH "AVE. STOR"

$Qp_3 = 175$ CFS ⇒ ELEV. ≅ 697.3 NGVD (RATING CURVE Pg. D-25)

ELEV = 697.25' NGVD ⇒ 775 ACRE-FT (STORAGE - ELEV CURVE - Pg D-29)

775 − 677 = 98 ACRE-FT = SURCHARGE STORAGE

$$\text{STOR 3} = 98 \text{ AC-FT} \times \frac{1}{0.34 \text{ M.}^2} \times \frac{\text{M.}^2}{640 \text{ AC}} = .45' = \boxed{5.4'' = \text{STOR 3}}$$

STOR 3 = 5.4" IS REASONABLY CLOSE TO AVE STOR = 5.68"

THEREFORE Qp_3 = ROUTED OUTFLOW = 175 CFS

SUMMARY

TEST FLOOD INFLOW = 434 CFS
TEST FLOOD OUTFLOW AFTER ROUTING = 175 CFS (WITH STOPLOGS)
TEST FLOOD ELEVATION = 697.3' NGVD
TOP OF DAM ELEVATION = 696.7' NGVD
AMOUNT DAM IS OVERTOPPED = 697.3 − 696.7 = 0.6'
THE CAPACITY OF THE STOPLOG BAYS WITH THE STOPLOGS AT AN ELEV = 695.0 AND A WSEL = 696.7' IS 73 CFS. THEREFORE THE STOPLOGS CAN PASS 42% (73/175) OF THE TEST FLOOD OUTFLOW (175 CFS)

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) DIVISION	(2) STATE	(3) COUNTY	(4) CONGR DIST	(5) STATE	(6) COUNTY	(7) CONGR DIST	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
1	33		005	02			MIRROR LAKE DAM	4456.8	7141.5	06	AUG	80

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
ER DAM	MIRROR LAKE

(15) SUBBASIN	(16) RIVER OR STREAM	(17) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(18) DIST FROM DAM (MI.)	(19) POPULATION
CT	TR-HUBBARD BROOK	VILLAGE OF WEST THORNTON	0	897

(20) TYPE OF DAM	(21) YEAR COMPLETED	(22) PURPOSES	(23) STRUCTURAL HEIGHT (FT.)	(24) HYDRAULIC HEIGHT (FT.)	(25) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(26) NORMAL (ACRE-FT.)	(27) DIST	(28) OWN	(29) FED R	(30) PRV/FED	(31) SCS A	(32) VER/DATE
ERTH	1964	R	13	12	750	677	NED	N	N	N	N	

(33) REMARKS

CONCRETE SPILLWAY BETWEEN 2 EARTH EMBANKMENTS 22-RECONSTRUCTED 20-1970

(34) SPILLWAY TYPE	(35) WIDTH (FT.)	(36) MAXIMUM DISCHARGE (CFS)	(37) VOLUME OF DAM (CY)	(38) POWER CAPACITY INSTALLED (MW)	(39) PROPOSED (MW)	(40) NAVIGATION LOCKS NO.	(41) LENGTH (FT.)	(42) WIDTH (FT.)	(43) LENGTH (FT.)	(44) WIDTH (FT.)	(45) LENGTH (FT.)	(46) WIDTH (FT.)	(47) LENGTH (FT.)	(48) WIDTH (FT.)
OGEE	10	75												

(49) OWNER	(50) ENGINEERING BY	(51) CONSTRUCTION BY
WATER RESOURCES BOARD		NH FISH AND GAME DEPT

(52) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

(53) INSPECTION BY	(54) INSPECTION DATE DAY	MO	YR	(55) AUTHORITY FOR INSPECTION
CORPS-NICHOLS & CO INC	09	JUL	80	PL92-367

(56) REMARKS

AND 5 FT STOPLOG BAYS 33-STOPLOGS IN PLACE AT 695 FT NGVD